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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The International Congress

The International Committee of Foundry Technical Associations, which was inaugurated by Mr. Paul Ropsy at a meeting held in Brussels in January of 1927, has certainly accomplished much, but has never essayed to control the manner in which the nine countries composing the membership shall organise their international congresses and exhibitions, only where they shall be held. This is as it should be, as any attempt at standardisation would rob participants of half the pleasure of these conferences. In Great Britain, for example, no attempt is made, nor is perhaps any attempt desirable, to interest the Government in its work; whereas, on the Continent, the status of the foundry organisations is probably enhanced by enlisting the co-operation of various ministries. Moreover, European congresses are taken much more seriously than at home. The Briton as a host constantly has in mind the material welfare of his guests and we cannot imagine him desiring to inflict upon them more than two, or at the most three, technical sessions. This is just mentioned by the way, to indicate that each nation should and must retain the organisation of its congress in accordance with national custom. We are perfectly certain that the majority of visitors to the last convention, held in England in 1929, must have been satiated with the number of formal banquets held in every one of the principal cities, and, of course, the metropolis.

The conference in Belgium which finished yesterday was what one might describe as "free and easy," as a maximum of elasticity was accorded for either lunching formally, by groups, or exploring new places individually. It had the great advantage of being held in the grounds of the great Brussels Exhibition, easily comparable both in size and interest to the British Empire Exhibition held about ten or more years ago at Wembley. This was unquestionably appreciated by the British delegation, which numbered about thirty. It is obvious that even if a serious attempt is made to translate speeches and Papers, much valuable time is taken up. Thus reliance is placed upon the foundry technical Press of the various nations to atone in some measure for the irreparable damage which originated (so we are told) at the construction of the Tower of Babel. Hence in this issue we have attempted to give to English-speaking readers full and abridged translations and extracts of the more important Papers presented. This service now established will be maintained in the future, and, if we can but receive the same collaboration from other countries as we have received from the Belgian officials, the value of international conferences will be materially enhanced. In this co-operation we very sincerely thank the Belgian Foundrymen's Technical Association, and especially Mr. Léonard, its President, and Mr. René Deprez, its indefatigable honorary secretary. We are sure that every visitor to Belgium will endorse our sentiments.

Recent Planning Schemes.—2
Mr. Lloyd George

There is a feeling that when the Government appointed the Commissioners for the special areas they were prepared to back them up, but it appears to have been somewhat disconcerted by the freedom and the frankness with which views have been expressed in the reports. They also examined at very great length the proposals of Mr. Lloyd George, called "Organising Prosperity," which have become widely known as our "New Deal."

The features of this programme are a prosperity loan of 250 millions to finance productive public works, especially during the next two years, and a National Development Board to act as a permanent authority in surveying industrial, agricultural and financial resources, planning economic progress and considering definite plans of action. The Bank of England would be placed under the control of a Board representing the financial, industrial and commercial interests of the nation, and the Cabinet would be reduced to the Prime Minister and four or five ministers without departmental duties. With regard to housing, two million dwellings are suggested within the next few years under a central planning board. With regard to power and communications, the whole main road system would be placed under the direct responsibility of the Minister of Transport, the main roads to be made into dual and one-way tracks, with footpaths and cycle tracks. Big projects would be put in hand, such as the Charing Cross bridge and tunnels at Liverpool and on the Tyne. The railways would be electrified and more completely unified. Air services would be developed, and also canals, harbours, and telephones. The retail distribution of electricity would be unified and mining royalties nationalised. Among industrial developments Mr. Lloyd George advocates an Iron and Steel

(*Concluded on page* 221.)

XUM

THE INTERNATIONAL FOUNDRY CONGRESS IN BRUSSELS

This congress, which is designated by the International Foundrymen's Committee as a "C" conference, that is, it is an international meeting of foundrymen without the active participation of the Americans, opened last Friday morning at the Brussels Exhibition. Mr. P. Van Isacker, the Minister for Economic Affairs, was in the chair, and immediately called on Mr. Léonard, the president of the Belgian Foundrymen's Technical Association, to address the meeting. Before giving his address of welcome, Mr. Léonard referred in touching terms to the sad loss which his country had suffered by the sudden death of Queen Astrid, and the meeting rose in silence for a minute as a token of homage. Mr. Léonard then recalled the history of these international foundrymen's gatherings, and very cordially thanked the various organisations for their close collaboration. Various Governments which had sent official delegates were also included. He surveyed in some detail the ground covered by the foundry industry, and showed how completely the different aspects were embraced by the Papers submitted.

A speech of thanks for the welcome was given on behalf of all the visitors by Dr. K. Gierdziejewski (of Poland), the President of the International Committee of Foundry Technical Associations, who voiced the feeling of everybody in commending the enterprise and initiative shown by Belgian foundrymen in the efforts to make the congress a real success.

The chairman, Mr. P. Van Isacker, after a speech stressing the importance of the foundry industry and the special position of Belgium in the export markets of the world, declared the conference open.

After luncheon at the Exhibition, a technical session was held, at which some nine Papers were presented and discussed. The first one, which was that by Mr. Lunt, president of the Foundry Trades' Equipment and Supplies Association, was "Developments in the Production and Use of Refined and Special Pig-Irons in Great Britain," and was presented by Mr. V. Delport.

MR. J. LÉONARD
(President of the International Foundry Congress).

Venues of Forthcoming Congresses Arranged

At six o'clock in the evening there was a meeting under the presidency of Mr. Gierdziejewski, of the International Foundrymen's Technical Committee. Mr. J. Léonard, of Belgium, was elected President for 1936, and the vice-presidency was offered to the American Foundrymen's Association with a certain recommendation which would be popular in European circles. The question of an international foundry directory, as usual, came up for discussion, but this year the proceedings were somewhat enlivened by a discussion as to a certain amount of co-operation with an international metallurgical conference which meets every five years. A very hearty invitation was given by Mr. J. E. Hurst, President of the Institute of British Foundrymen, to hold the conference for 1939 in Great Britain. This was accepted, so that the programme for the next few years is 1936, Germany (Düsseldorf); 1937, France (Paris); 1938, Poland (Warsaw); and 1939, Great Britain.

H.M. KING LEOPOLD III
(Patron of the International Foundry Congress).

THE WORKS OF NESTOR MARTIN

There was a change in the programme announced for Saturday morning, and instead of visiting the National Radiation Works, an invitation was accepted to inspect those of the Nestor Martin Company. The choice could not have been better, as a fairly wide range of light castings is made by this company, including coke-, gas-, and electrically-heated stoves and cookers, gas-fired radiators for schools and churches, switchgear and a number of other jobs. The British party were particularly fortunate in the guide placed at their disposal, as, having been educated at Winchester, he had a very sound command of the English language. The visit was arranged to work "backwards," that is, a start was made at the assembly end, then through the vitreous-enamelling department, which is of very considerable dimensions. Tar oil was used for the firing of the enamelling stoves, and both the dry and wet processes were being practised. Leadless enamels were used, and it was stated that any colour, including light green, could be obtained.

A splendid plant was installed for surface grinding the plates before enamelling. It was entirely automatic and completely covered the surface to be treated. All cast-iron ware was given a ground coat.

The foundry itself was highly mechanised, the plant being a combination of French (Baillot) and German design. The turntable design employed has already been well described in a Paper* by Mr. A. S. Beech. The knock-out was not mechanised, but the grating was covered by a wooden frame to give a "kinder" blow to the steel boxes which are used. The mould conveyor is unique, as the tables are suspended (not as pendulum), and covered by a roller path, placed at right-angles to the direction of travel. Immediately after the pouring section, the moulds disappear below ground, where they are cooled, and on reaching floor level again they are pushed off to the knockout. Over the line of the mould conveyor, is mounted a series of sand hoppers, which, although inoperative at the time of the visit, are so arranged that they can feed, by means of a length of belting, a number of hand-moulding machines. We presume that there would also be a length of roller conveyor to feed back on to the mould conveyor. "Silica" sand, previously dried, is the basis of the mixture used, which is prepared in Baillot plant. It was pleasing to see that British pig-iron was extensively used. The mechanised foundry was supplemented by an ordinary floor, such as one encounters in this type of foundry in Scotland and England, but with the difference that the moulder is supplied with ready-mixed sand. All around this section at regular intervals there were repeated two notices—one which drew attention to the importance of venting, and the other to the necessity of slagging ladles in the alleyways and not on the casting floors. This foundry at the moment is casting about 20 to 25 tons of

MR. K. GIERDZIEJEWSKI
(President of the International Foundrymen's Technical Committee).

* FOUNDRY TRADE JOURNAL, Vol. 50, p. 7.

iron a day, but is capable of larger production. During an inspection of the pattern stores and despatch departments, it was noticed that a system of coloured lights, associated with a warning bell, was in vogue with the object of quickly getting the principal officials to the 'phone. This system is still too infrequently met with at home.

The visit concluded with light refreshments and a very charming speech of welcome by the works manager. Prof. Pisek, of Czecho-Slovakia, thanked the management on behalf of their guests.

A Civic Reception

A communal luncheon was taken in the city at the Taverne Royale, and during the afternoon a further six Papers were presented and discussed. At 6 o'clock in the evening a civic reception was accorded to the visitors at the Hôtel de Ville, where Mr. Adolphe Max, the illustrious Burgomaster, personally welcomed the delegates. After twenty-five years of office, coupled with a particularly strenuous time because of the great Exhibition, the venerable and charming old gentleman had asked to be excused from making a speech. The various halls, tapestries and pictures will long remain in the minds of the visitors as forming a worthy interior to Europe's most artistic and best preserved of mediæval squares.

An Excellent Precept

On Sunday morning foundry foremen from all parts of Belgium assembled at a hall within the Exhibition, under the chairmanship of Mr. Léonard, when nine more Papers were discussed, dealing with: (1) Classification of Steels and Cast Iron; (2) Foundry Tools; (3) Sand Control; (4) Cupola Control; (5) Determination of Temperatures; (6) "Life" Tests; (7) Determination of Hardness, when Ramming Moulds; (8) Test-Pieces for Ascertaining the Quality of Cast Iron, and (9) The Examination of Wasters.

The Lancastria Banquet

On Sunday evening a large number of the British delegates participated in a banquet, at the Hotel Plaza, which reunites foundrymen of all nations who crossed to America in 1926 for the first international conference to be held in that country. The organisation, invariably brilliant, is in the hands of Mr. F. S. Russell, F.G.S., and performs a more than useful function in cementing the bonds of friendship established so firmly between the foundrymen of the various countries.

The whole of Monday was given up to visiting Bruges, certainly one of the most interesting cities in Northern Europe, as it is still redolent of mediæval grandeur.

On Tuesday, business was resumed, and the morning was devoted to a visit to the works of the Union des Aciéries at Marcinelle, near Charleroi, and in the afternoon a third technical session was held, whereat a further seven Papers were discussed. Included amongst these was the British Exchange Paper: "The Machinability of Cast Iron," by Mr. H. H. Beeny. This was presented by Mr. V. C. Faulkner. Later in the day a meeting of the International Test Bar Committee was held, under the presidency of Prof. Portevin.

Yesterday, eight more Papers were discussed, and in the evening, at the special request of His Majesty the King of the Belgians, the closing banquet was held, but without the presence of a Minister of the Crown. This was held at the Hotel Metropole, and about 350 guests assembled. At the closing ceremony the announcement was made that Mr. Léonard had received the Order of Leopold.

LIST OF BRITISH VISITORS ATTENDING THE CONGRESS

Baines, C. (Stoke-on-Trent); Burgess, C. J. (Banbury); Cameron, J. (Past-President of the Institute of British Foundrymen) (Kirkintilloch); Cameron, Mrs. J.; Delport, V. (London); Delport, Mrs. V.; Evans, S. (London); Everest, Dr. A. B. (London); Faulkner, V. C. (Past-President of the Institute of British Foundrymen) (London); Faulkner, Mrs. V. C.; Gilbert, T. F. (London); Harper, W. E. (Dudley); Hooper, B., C.B.E. (London); Hooper, Mrs. B.; Hurst, J. E. (President of the Institute of British Foundrymen) (Sheffield); Jeans, H. (London); Jeans, Mrs. H.; Kent, B. B. (London); Kilner, Mr. (Sheffield); Lockwood, H. W. (London); Longden, E. (Manchester); Longden, Mrs. E.; Lunt, G. T. (President of the Foundry Trades' Equipment and Supplies Association); Makemson, T. (General Secretary of the Institute of British Foundrymen) (Manchester); Minter, Sir F. (London); Nichols, Mr.; O'Connor, T. S. (Ireland); Primrose, J. M. (Falkirk); Primrose, Mrs. J. M.; Russell, F. S. (Sheffield); Russell, Mrs. F. S.; Russell, Miss; Russell, jun., Mr.; Smith, R. H. (London); Todd, W. (Birmingham); Wharton, H. (Sheffield); Winterton, H. (Vice-President of the Institute of British Foundrymen) (Glasgow).

Recent Planning Schemes

(*Concluded from page* 219.)

Board to control the industry, to plan its policy, and a controlling authority for the cotton industry. The shipping industry would be reconstructed and the southern drift of industry checked.

The agricultural proposals are extensive and do not concern us directly, but the raising of the school-leaving age to 15 is advocated, with a reduction in the weekly hours of labour and a 5-day week, followed by pensions at 60 with retirement from paid employment.

The parallels between these proposals and those of the special area Commissioners can be readily followed. Mr. Lloyd George says that at a conservative estimate there are 200 millions a year of national savings available for sound and useful investment; on the other hand there are two millions unemployed. The State has to spend yearly a sum equivalent to the income on a capital of 3,500 millions in order to finance, not industry, but idleness. There are still immense possibilities inside the Empire in undeveloped or partly developed countries like India or the Colonies, and the possibilities of expansion of international trade in Russia and China. This will give some idea of the scope of the proposals put forward by Mr. Lloyd George which are being pressed politically by his Council of Action. Mr. Lloyd George says that a prosperity loan for national development of £250,000,000 could be raised at 3 per cent., or with a sinking fund, say 3½ per cent., or under £9,000,000 a year. New regulations for the expenditure of the Public Assistance Board on maintaining the unemployed will cost an increased annual sum of almost as much.

Thermal Conductivity of Refractories

In "Sprechsaal Keramik," H. Salmang and H. Frank discuss investigations on the measurement of the thermal conductivity of refractories at high temperatures up to 1,400 deg. C. Observations on magnesite, sillimanite, schamotte, silica and carborundum showed that with sillimanite the pores and with carborundum-type refractories the alumina contents have a marked effect on the thermal conductivity.

(*Concluded from next column.*)

have a penchant for mussels and chips, do not drop the paper in the exhibition, as the local police will "nab" you. (4) The Bavarian bar and cabaret with pseudo-inter-racial osculations is a matter which unquestionably amuses the British foundry tourist when he is well "münchenised."

"Marksman."

Random Shots

Twenty-two and "a-half" intrepid representatives of the British foundry industry last Thursday foregathered at Victoria, and, after scanning the weather board, which boldly announced "Gales from the South-West," tightened their belts, ordered up Mothersills, beer, whiskey and soda, or morning coffee according to the advice tendered by their general practitioners, local barmaids, bosum ("Marksman" nearly said boozing) friends, and, taking their places in specially-reserved compartments, began to discuss the pig-iron situation. These heroes and heroines created a world's record—they all reported at Ostend, "fit and no *mal de mer*." Actually, although the seas were mountainous, it was not too bad, as there was a following wind. In fact, Mr. Russell's ciné pictures would have looked just as fine on the ship as in the train. Of course, there were the usual difficulties. One member had forgotten his passport, and another ordered tea instead of hock out of pure force of habit. One thing worried "Marksman." He was constantly being asked whether lipstick was soluble in alcohol. He doesn't know, and as alcohol is prohibited in Belgium, he will have to defer experiments until he can persuade Milly—his favourite barmaid—to sample a pink gin.

* * *

The Story of the Exhibition

Overheard in the lounge of the Metro Ritz:—"Good heavens, old man, there's my wife and mistress coming in together." His companion: "My goodness, you took the very words out of my mouth!"

* * *

More heroism was displayed at the opening ceremony. For two hours the very important "délégation anglaise et ses dames" sat as good as gold, and cheered, and said "Hear, hear" or "Shame," when the more erudite of the community indicated that such expressions were justified and would be appreciated by our charming hosts.

* * *

It was here that most of us met for the first time Señora Vanzetti, the very recently acquired American bride of Dr. Guido Vanzetti. We all look forward to meeting the Signora in Düsseldorf, Warsaw, Paris and London. This is a spot of advance information as to the *locale* of forthcoming congresses. The welcome to the guests expressed by Mr. Léonard was a masterpiece of oratory, and the reply by the President of the International Foundrymen's Committee, Mr. Gierdziejewski, of Poland (pronounced Gierdziejewski) was all that it should be, and no League of Nations inquiry is likely to result. A Minister of the Crown, Monsieur P. Van Isacker—actually the Minister of Commerce—presided, and he spoke so clearly and distinctly that "Marksman" received the impression that he had mastered the art of understanding at least one of these foreign tongues.

* * *

Tips for visitors to the Brussels Exhibition:—(1) The unnamed palace is the best of the lot—on entering, it will be realised that this is the one staged by His Britannic Majesty's Government. Excellent publicity! (2) Real Czecho "piwow" ("Marksman's" regular readers have learnt that this is one of the three Czechi words he knows, and means beer; the other two are "Damy" and "Pani"), hot dogs, and caraway-besprinkled rolls are available opposite the Italian building. (3) It is inadvisable indiscriminately to mix Stella, *moules et frites* and ices, and if you

(*Concluded in previous column.*)

SOME OF THE PAPERS READ AT THE CONFERENCE

Developments in the Production and Use of Refined and Alloy Pig-Irons in Great Britain*

By G. T. LUNT

The term "refined iron" has been familiar in the iron trade for many years, but in spite of this there has always been some uncertainty as to the exact meaning and the character of the product it was intended to convey. This uncertainty appears to arise from the loose and indiscriminate use of this term even from its earliest inception, which dates back probably to the middle of the eighteenth century. In the abstract, the idea of refining as applied to pig-iron may refer to any treatment to which blast-furnace pig-iron is subjected to make it more suitable for a particular operation. The actual character of the refining operation may consist of the removal of some of several objectionable constituents or it may consist of the admixture of other desirable constituents or special treatments designed to improve the characteristics of the iron for the particular purpose for which it is intended.

To-day the use of pig-irons in the preparation of specifications for cast-iron castings is characterised by a totally different outlook from that prevailing, say, 20 years ago. In addition to the influence of chemical composition, the influence of the condition, structural characteristics and thermal treatment of cast irons are better understood from the point of view of their influence on the character of the final product manufactured. Under these circumstances, there now exists, on the one hand, a demand for supplies of irons having certain well-defined properties and characteristics for different purposes, and, on the other hand, irons are now produced fundamentally from blast-furnace pig-irons by re-treating them in various ways to satisfy these requirements. These special irons constitute the classification of modern refined pig-iron, and may be defined as those pig-irons prepared by re-treating blast-furnace pig-irons with the object of improving their properties, qualities and characteristics for given special requirements.

During recent years remarkable developments have taken place in connection with the treatment and composition of cast iron, so that this material has assumed an entirely new significance in the eyes of the machine designer. As in the case of steel, there is now available a wide range of alloy cast irons possessing special properties, rendering them suitable for particular applications. Refining processes and refined pig-irons have played an important part in making possible this progress and it is easily perceived from the direction in which these developments are tending, that the economic importance of refined pig-irons will be still greater in the production of cast irons possessing special properties for particular applications.

The leading manufacturers of refined irons, by the utilisation of various processes of melting, superheating and after-treatment of molten metal, by their own intensive research into the characteristics of irons and the effects of blending and modifying processes on the mechanical and structural properties, have been enabled to supply to the ironfounder raw materials possessing special properties, which can be maintained accurate and uniform. For example, in those irons which come within the category of refined cylinder irons, there are manufactured irons having superior strength properties, irons having intrinsically high moduli of elasticity, irons having specific magnetic permeability characteristics, irons having specific structural characteristics, inoculated and fine graphite irons, all these in addition to specific requirements of chemical composition, as for example, low total-carbon, high total-carbon, and the various guaranteed limits of compositions required in individual specifications.

Inherent Properties and Blending

Perhaps the most important of the many developments in the production of refined pig-irons is the development of systematic mixing and blending of the materials on the basis of their mechanical strength properties in addition to their chemical composition. In the ordinary system of blending based upon the chemical composition alone, the complete chemical analysis of the incoming raw materials is used and by selection of suitable compositions of raw materials mixtures are made up to produce the final desired composition. This system has now been reinforced to enable irons to be produced not only to meet a final desired chemical composition, but also a final desired mechanical strength specification. The mechanical strength specification is laid down in terms of the following attributes of the strength properties:—Modulus of rupture; modulus of elasticity; resilience value; limit of proportionality and character of stress/strain curves, and permanent set value and elastic hysteresis curve.

For full definition of these properties and their significance, reference can be made to the various Papers by Hurst (*e.g.* FOUNDRY TRADE JOURNAL, February 21, 1935, Proceedings of Manchester Association of Engineers, 1932, and others), where it has been shown that individual types of pig-iron show variations in these properties, independently of their chemical composition. It will be appreciated that by the selection of raw materials on the basis of these properties in addition to the chemical composition, it becomes possible to blend them to obtain a wide range of predetermined mechanical strength properties. By making a study of these properties in a particular grade of pig-iron, information is obtained which enables them to be matched exactly by blending together suitable materials. At first sight, the measurement of all these attributes of the mechanical strength properties appears to be a somewhat formidable task. As a matter of fact, it is very greatly simplified by the use of the ring form of specimen and the method of testing such specimens as laid down in Air Board Specification 4K6 and fully described in various Papers by Hurst. A specially-designed testing machine used in the laboratories of the firm of the author greatly facilitates this work, and enables the mechanical analysis of incoming raw materials to be undertaken readily, in addition to the investigation of the properties of irons required to meet customers' requirements. The systematic blending of irons on the basis of this type of mechanical strength analysis has not only enabled the inherent properties of various types of pig-irons to be matched exactly, but has enabled these characteristics to be produced with a greater degree of regularity and uniformity.

Application of Blending Methods

These methods have been utilised to show that the whole of the known characteristics of cold-blast pig-irons can be completely duplicated. It is now used with complete success, and by its means refined irons can be produced, duplicating exactly not only the composition and intrinsic strength properties, but also the chilling characteristics of this class of iron. The results included in Table I will serve to illustrate this, showing as they do the complete chemical and mechanical analyses of a sample of true cold-blast iron submitted for matching, and those on both a successful and unsuccessful attempt at securing a match complete in every respect.

TABLE I.—*Chemical and Mechanical Analyses of a Cold Blast Iron and Blended Refined Iron Substitutes.*

	True cold blast specimen.	Successful blended refined substitute.	Unsuccessful blended refined substitute.
Total carbon, per cent. ..	3.55	3.62	3.70
Silicon, per cent.	1.83	1.96	1.95
Manganese, per cent. ..	0.87	0.90	0.95
Sulphur, per cent... ..	0.050	0.042	0.029
Phosphorus, per cent. ..	0.48	0.50	0.51
Nickel, per cent.	Nil	Nil	Nil
Chromium, per cent. ..	0.050	0.031	0.026
Tensile strength, tons per sq. in.	20.6	21.2	16.5
Resilience value	20.6	19.8	14.4
Permanent set, per cent. ..	12.5	10.9	30.6
Internal stress	0.003	0.005	0.004
Modulus of elas. EN value	18.7	17.9	13.5
Brinell hardness	215	207	207

The Degasification Process

This process and the developments arising out of it have played a part of great importance in the production of high-grade refined pig-irons. The Bradley degasification process, introduced and patented some years ago by the firm with which the author is associated, has been developed and extended in its applications, and has proved invaluable in assisting in the control of the structure of pig-iron in addition to its effect on minimising the effect of dissolved gases and suspended inclusions. In the process as carried out at the author's work, the plant at which consists of a large unit capable of treating quantities of 10 to 15 tons at a time, the molten metal is taken from the refineries for treatment. The degasification plant consists of a large oil-fired cylindrical furnace and the treatment is effected by means of a powerful stirring device lowered into the metal after the removal of the furnace roof. The molten metal collected in the furnace is superheated by means of the oil firing, and then subjected to a powerful stirring or agitation by means of this stirring device. This device consists of four vertical rods, coated with refractory material and arranged to rotate at different radii. The period of time to which the metal is subjected to agitation is dependent on the character and amount of metal to be treated.

The agitation produced is of a violent character, and the molten mass of metal acquires a rotational velocity of something of the order of 400 ft. per min. The advantageous effect of

*Paper presented to the International Foundry Congress, on behalf of the Foundry Trades' Equipment and Supplies Association of which the Author is President.

violent agitation and rotation of molten metal has been repeatedly referred to, and a variety of different methods have been developed from time to time. As examples, it is only necessary to refer to the Duchêsne process and the pre-solidification and gas agitation processes used in the non-ferrous industry for promoting soundness and freedom from defects. Violent agitation tends to eliminate dissolved gases and suspended impurities, but it is only recently that it has come to be realised that it has an important effect in producing a finely-crystalline condition in the solidifying metal. The important effect of finely-divided graphite, for example, has assumed fresh importance in the light of modern research work, and processes of this nature have placed at the disposal of refined pig-iron manufacturers methods of controlling these structures in the initial pig-iron.

Refined Malleable and Cylinder Pig-Irons

The production of a wide range of specifications of pig-irons for use in the manufacture of malleable castings and high-duty grey-iron castings of which engine cylinders, pistons and piston rings are typical, constitutes a very important section of the activities of the refined iron manufacturer. The application of the principles of systematic blending and the treatment by means of the "degasification" process has enabled a very high standard of quality to be obtained. The importance of these developments lies not only in obtaining a high standard of quality, but also in the fact that greater control of the nature, occurrence and uniformity of these properties is rendered possible. This serves to demonstrate one of the most important aspects of the economic value of refined irons to the high-duty ironfounding industry. This, of course, lies in the extreme flexibility of the refining processes, coupled with the facility for the exercise of the strictest possible control over all these considerations of composition, physical and mechanical characteristics which are necessary in all high-duty irons.

Refined Alloy Pig-Irons

Nowhere is this more apparent than in the new application of refining processes to the production of alloy pig-irons. The production of various types of alloy cast-iron castings is a rapidly growing section of the ironfounding industry. Chromium and nickel-chromium cast irons are finding use in the production of heat-resisting and wear-resisting castings, suitable for heat-treatment by hardening and tempering. Nickel and other alloy additions are attracting attention in the production of high strength and martensitic castings. The production of austenitic cast irons having specific corrosion-resisting, heat-resisting and specially high thermal expansibility and non-magnetic properties is now an important section of the ironfounding industry. In many of these alloy cast irons, the alloy additions in substantial quantities are essential, and it is hardly necessary to set out in detail all the reasons, both technical and economical, which render the strictest accuracy of composition essential to the successful production of these cast irons.

The value of refined alloy pig-irons as an aid to the successful production of alloy cast irons is best exemplified by a description of the refined chromium-alloy pig-irons specially designed for the addition of chromium, one of the most important of the special alloy additions. The ferro-chromium alloys are the most common source of chromium for alloying purposes, and such alloys are available from the "carbon-free" varieties up to those containing 8 to 10 per cent. carbon. The melting point of pure chromium is high, *viz.*, 1,615 deg. C. as compared with cast iron at 1,150 deg. C. The ferro-chromium alloys are likewise very refractory and in the high chromium alloys containing 6 to 8 per cent. carbon, there exist compounds which only melt completely above temperatures of 1,600 to 1,700 deg. C. These considerations entirely rule out the possibility of adding chromium to the necessary degree of accuracy as ladle additions. Even in the cupola there is considerable difficulty in ensuring the complete melting of ferro-chromium apart from the potentially high losses and irregularities invariably associated with the addition of elements in concentrated form in this manner. The use of refined chromium-alloy pig-irons provides the most satisfactory method of making accurate additions of chromium to the cupola mixture. A typical range of refined chromium-alloy pig-irons is given below:—

Brand.	T.C.	Si.	Mn.	S. max.	P.	Cr.
C.C. ..	2.9–3.1	To suit re-quire-ments	To suit re-quire-ments	0.08	To suit re-quire-ments	2.2–2.5
C.E. ..	2.9–3.1			0.08		2.75–3.0
C.F. ..	3.5–3.75			0.08		7.75–8.0

The composition of the brand C.F. is approximately that of the ternary eutectic of the iron-carbon-chromium series which, in accordance with von Vesesack's determination lies at 8.0 Cr., 3.0 C, and 88.4 per cent. Fe, with a melting point of 1,050 deg. C., somewhat lower than that of high-duty cast iron. The addition of approximately 17 to 20 lbs. of this pig-iron per cwt. of metal provides an addition of 1 per cent. chromium. Incidentally, these high alloy content pig-irons are produced in the form of small sand-cast or machine-cast pigs to facilitate accurate weighing of small quantities and also their use in crucible and hearth type furnace.

For the addition of others of the alloying elements, such as nickel, molybdenum, tungsten, vanadium, silicon, etc., similar rich refined alloy pig-irons are available, and their utility and economic value are based on exactly the same considerations. Refined alloy pig-irons containing chromium and nickel, either singly or conjointly in smaller quantities, are available for direct use in the production of the various alloy cast-iron specifications. The refining processes have also been adapted for the production of special alloy cast irons in ingot form of such compositions that on remelting either in the crucible or cupola, the correct composition is obtained. These irons are invaluable to the founder in the production of austenitic cast irons of the Nicro-Silal and Ni-Resist type, in enabling their production to correct specifications, both in regard to chemical composition and structural characteristics being ensured.

Sufficient has been written to demonstrate the importance of refining processes and refined irons in the production of high-duty cast-iron castings, and there can be no doubt that the rapid growth in the development of such cast irons during the last few years has been assisted in a very large measure by refined and refined-alloy pig-irons.

"Steel and Attendant Industries"

The British Steelwork Association, Artillery House, Westminster, has issued a well-illustrated handbook, "Steel and the Attendant Industries," which serves to emphasise the vast importance of the steel industry, interlinked with the coal and chemical industries, to the economic life of the nation. It surveys the mining of iron ore and coal, the coke-oven by-products industry, limestone, pig-iron making, the production of steel and finished steel, and the testing of steel. The booklet presents a most interesting summary of the ramifications of the British steel industry, and, as it is written in simple language, it has a general appeal and should be widely distributed.

Protection of Buried Pipes

According to "Maschinen Schaden," buried iron and steel pipes may be protected against corrosion by embedding them in water-glass slurry, which is a by-product in water-glass manufacture.

Churned Iron and Soda Treatment

By Prof. L. E. C. Girardet.

[Extract.]

The abstractor has used the word "churned" because so many words related to the centrifugal treatment of liquid metals have been associated with other processes which are current in Great Britain.

The Fonte Girée, which has been developed by the author, refers to iron cast into a receiver which is rotated at a critical speed. The iron so produced is characterised by the fact that the grains all resemble each other from the point of view of size and colour. They have a very different shape from ordinary irons in which heterogeneity is marked.

The author has passed in review many experiments and inventions which have a bearing on the purification of cast iron. He refers, for instance, to the classical experiment of Osan, who kept a crucible of iron liquid for eight days, after which time there was a thick layer of graphite covering the surface of the metal. The resulting metal had acquired very remarkable properties. It was called eutectic iron, whilst the floating graphite was designated as "kish." The author has put forward the following definition of eutectic iron:—

"Eutectic iron is that in which the elements present are not in excess of the quantities corresponding to their reciprocal solubility in the liquid state at any given moment."

The Professor's researches have been carried out with the object of inducing physico-chemical equilibrium in the metals produced.

After dealing with mixer metal and with the experiments of Steward in 1883 and White in 1920, the author deals with the improvement of cast iron by chemical methods, such as the addition of alloys and the use of reactive slags, which leads him to the development of soda ash. It seems, according to the Professor, that this method is not new, and he refers to experiments made at the Ebbw Vale Company in 1860, and points out that in 1930 no less than 4,200 tons of soda ash were consumed in the American metallurgical industries. Soda ash degasifies, deoxidises and desulphurises cast iron and eliminates emulsified slag. Because of this multiple action it profoundly modifies the structure and the properties in the same way as does spontaneous physical purification. From these premises, and with the object of providing a better class of iron the author describes a process which includes both mechanical agitation and chemical reaction. He points out that true centrifugation is opposed to the interpenetration of reactives and reactives, and acts as a separator rather than a mixer; thus only agitation or churning of the metal is necessary in order to eliminate noxious products accumulating in the intergranular cement. When iron is churned mechanically beneath a layer of liquid soda ash, there is a slipping of the metal in contact with the slag, which moves slower because of its lower density. There is therefore a rubbing action which tends to make the iron roll over itself, and in doing so envelops the soda ash. This promotes ideal conditions for the carrying out of both chemical and physical reactions for inducing a nodular structure. In order to satisfy himself on this point of intermixing, the author experimented with a receiver of about 2 cwts. capacity. This receiver was rotated until the slag solidified, after which rotation was stopped and the metal cast and allowed to cool. The loaf of slag remaining in the receiver had entrained a multitude of globules of iron, of which the largest was about 5 mm. diameter, whilst the smallest were of microscopic proportions. These

(*Concluded on page* 236.)

Spongy Spot and the Léonard Effect

By M. KAGAN

Of all defects known to the foundry, that of spongy spot is the commonest and most serious. This applies equally to the iron and non-ferrous foundry. When this defect occurs, castings which have to contain either liquids, vapour or gases, preheated or not, and at atmospheric or higher pressure, become practically unuseable. There are other types of porosity, such as the intercrystalline porosity and porosity due may be to the presence of kish mechanically entrained in the metallic mass in the case of strongly hypereutetic irons, or may be to the presence of large graphite plates, which cut across the thickness of the metal.

The word " porosité " is quite often used for defects which are not necessarily related to unsoundness. Thus, pinholing, blowholes, draws, slag inclusions, are not necessarily porous places; they can introduce porosity if the pinholes form a continuous chain or if a blowhole is not enclosed, and also if inclusions are carried across the thickness of metal in a manner similar to porosity introduced by other defects, but such porosity is purely accidental. It is, however, theoretically true that no cast iron is absolutely sound, and that all irons

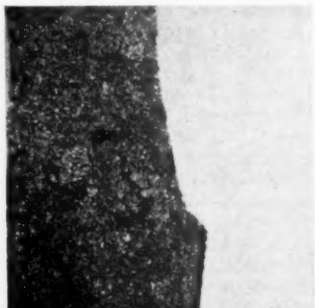


FIG. 1.

possess a certain intercrystalline porosity due to the discontinuous reduction of volume during solidification. Practically speaking, this porosity rarely constitutes a true foundry defect.

Tests made by forcing colouring matter through iron have shown that it is necessary for pressures to reach 200 to 800 atmospheres before irons can be considered as being porous. It is quite another question in the case of spongy spot. Spongy spots are always synonymous with unsoundness and porosity. When a casting possessing a spongy spot is broken, a fracture in the defective region will be noticed to be quite characteristic and abnormal. It shows a colour varying from light yellow to deep black. Even to the naked eye the presence of a series of small canals can be noticed, which traverse the metal and cause it to resemble a sponge. Hence the name " spongy spot."

Canals from Essential Feature

Under the microscope or with a simple magnifying glass, or even with the naked eye, quite often the primary crystallisation in the form of dendrites can be seen. In many cases it is noticed that in the spongy area connected with the outside (or with the core) by one or several canals, the presence of this canal or canals is not essential. They may be closed after solidification by a more or less thick film of metal. In this case, the sponginess does not show up until after machining and the cutting off of this metallic film. Under pressure, often quite low, or even at atmosphere pressure, drops will be noticed traversing the metal when it contains very penetrating or low-viscosity liquids.

According to the size of the canals, rust can close them, and the area may become sound in appearance, yet in many cases the size and dimensions of the canals are such that, in spite of all efforts, porosity persists. An attempt to close the canals by cementing them reveals the existence of a large cavity representing the sum of all the channels.

Figs. 1 to 4 show some shapes of spongy spot. Fig. 1 illustrates a fracture to be associated with cast iron. The spongy area is shown between *aa* and presents a yellowish appearance. Fig. 2 shows the same fracture polished but unetched and at two diameters. A series of canals is shown to be covering the surface of the fracture. Fig. 3 shows the same fracture unpolished but magnified 50 times and the outlines of the canals are clearly shown. Finally, Fig. 4 shows the same fracture polished and etched. The magnification in this case is 25. Dendritic crystallisation is shown up as are also several kills which look different from it.

In the actual foundry there is no agreement as to the cause or causes bringing about this defect. The form of the pattern; the form, dimensions and setting of the runner; the quality of the metal; the influence of certain elements, especially vapours; segregation; method of melting and casting; the temperature of the metal; contraction—are all suspect. However, a close examination of porosity seems capable of giving data which allows of the partial explanation of the character of this defect, and the mechanism of its formation, together with the probable and principal agent responsible for this particular defect. Thus, if the process of the solidification of metals and other alloys be considered, the actual state of existing knowledge of this process can be postulated as follows:—

In the case of an alloy, solidification takes place in the freezing range, which can be measured on a diagram of the distance between the liquidus and the solidus. In the molten mass giving birth to primary crystallisation which progressively with the decrease of the temperature increases in the mother liquor, the crystals first freezing take the form of dendrites of some particular form. The phenomenon of the increase of the dendrite continues until it meets with an obstacle created by the increase of the neighbouring dendrites. The crystals continue to be deposited until the thickening of the mother liquor, or until the formation at a definite temperature of a eutectic in which is involved the primary crystallisation. At that moment solidification is complete. The crystalline edifice thus formed in the solidus rarely persists down to ordinary temperature. It is destroyed and transformed during its passage by lines of transformers. Referring again to Fig. 4, it is now possible to make the following observations:—

(1) The presence of dendrites with unfilled interdendritic spaces shows that here is presented a phenomenon of which the action has taken place during the formation of the primary crystalline edifice whilst the metallic mass is still pasty, that is to say, during the passage from the liquidus to the solidus.

(2) The presence of canals and voids between the dendrites seems to indicate that there has been a circulation of fluid gases under pressure, which, in expelling the liquid metal, has prevented the crystalline system from completing itself.

(3) The connection of the spongy spot with the outside and the discoloration due to oxidation shows that this fluid has entered the metallic mass from outside, and in the case of sand moulds from the mould or from the core.

It would seem, therefore, that the main and probable causes of spongy spots are the gases brought into the metal either by the Léonard effect, that is to say, by a local and excessive heating of protruding portions of sand, or by the tendency of the core gases to penetrate in the liquid metal because of certain pressures. A simple test, but a very conclusive one, confirms the postulations.

A Sleeve Defect

Fig. 5 shows a sleeve for a coupling cast in a dried mould with the flange uppermost. Under certain conditions of casting, the Léonard effect and the spongy spot is introduced in the areas *aa*. This sponginess is probably due to the overheating of the ring of sand (*bb*) and to reactions resulting therefrom. Thus, it is sufficient to replace the suspect ring of sand by a loam cake heated to redness in order to eliminate the major portion of the possibly dangerous reactions, so that the spongy spot will disappear in spite of the maintenance of all the other conditions. This is

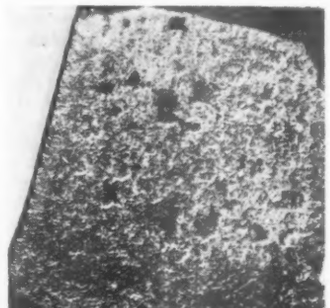


FIG. 2.

equally true for bronze as for cast iron. The mechanism of the formation of sponginess can be said to be as follows:—

When liquid metal is introduced into a sand mould, besides the air contained in the mould and the included gas, there is a formation of gas and vapour, because of the action of the metal on the constituents of the sand. Moreover, there is an immediate formation of solidified skin or crust formed by the contact of the metal with the walls of the mould. It follows, then, that if the mould does not have conditions favourable for the Léonard effect to appear, the filling of the mould is carried out under normal conditions. It will form a thin solidified skin which, like a box, will contain the remainder of the metal. Solidification will continue by the progressive increase in the thickness of the box. This solidified skin stays thus between the liquid metal of the mould sand and preserves the latter from the immediate action of the former. It is through this solidified skin that the transmission of the heat of the metal is carried to the sand. The heating of the latter will be slow and uniform, because of its poor thermal conductivity. The gases formed after a sufficient increase in the temperature of the sand will find that this solidified crust presents an obstacle in front of them.

The Léonard Effect

Everything is quite different in the case of the possibility of the formation of the Léonard effect. The protruding part of the sand, because of its position relative to the metal, or because of the flow of a large quantity of metal in its neighbourhood, is submitted to an excessive local heating up. This will bring about a corresponding local heating up of the formation of the solidified crust. This slowing up of cooling results in a still greater heating up of the small protruding piece of sand, because of the

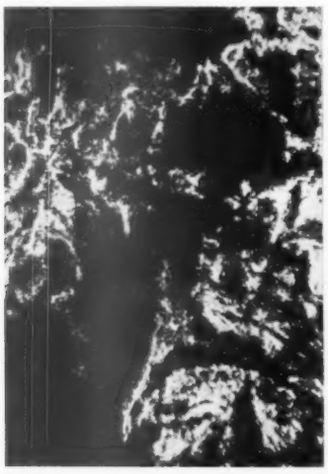


Fig. 3.

prolonged and more intimate contact with the liquid metal. The reactions brought about by the action of the metal on the sand are thus produced much more energetically, and in direct contact with the metal at the time of solidification. It still remains to determine what is this reaction or principal reactions which play the principal part in this phenomenon, and this complex problem can quite usefully be the object of further researches.

Before leaving this dried mould, Fig. 5, of which the stoving temperature was about 250 deg. C., and the loam cake heated to redness, at about 900 deg. C., it would seem that the upper and lower temperature limits between which the reactions in question can be produced have already been determined. The reactions which can be presumed to take place in the mould because of the action of metal on sand are as follow:—

(1) The evolutions of the water vapour in the sand which persist even in a mould stoved at a temperature of about 500 deg. C. (1 kilogramme of water evolves about 1,800 litres of vapour).

(2) The dissociation of clay in the sand. This dissociation commences at 200 deg. C. It reaches a maximum between 200 and 400 deg. C., and is according to the following formula:—

$$(Al_2O_3 . 2SiO_2 . 2H_2O = Al_2O_3 + 2SiO_2 + 2H_2O).$$

(3) The dissociation of a kilogramme of silicate of alumina gives an average of 500 litres of vapour, this quantity evolving according to temperature and pressure.

(4) The decomposition of the limestone and magnesia. The former takes place at about 1,200 deg. C. and lower according to the reaction ($CaCO_3 = CaO + CO_2$). One kilogramme of limestone will give about 1,500 litres of gas.

(5) The decomposition of compounds of iron which are present in sand as ferric-oxide and ferric-hydrate—$Fe_2(OH)_6$. The decomposition of the latter is as follows:—

$$(Fe_2(OH)_6 = Fe_2O_3 + 3H_2O)$$

and evolves for each kilogramme of hydrate about 750 litres of vapour. Iron oxide can start to react with carbon of the iron and evolve carbon monoxide. This is a very violent reaction, which starts at about 850 deg., and unquestionably is at the root of many foundry defects.

The gases, evolved by reason of these possible reactions, penetrate under high pressure due to the increase of their volume, into the metal at the time of the formation of the crystalline edifice. Practically speaking, the spongy spot, due to the Léonard effect, exists in most castings, because it is rare to find a pattern of which the conception or the method of casting renders impossible the incidence of this effect. It is only in machined castings tested under pressure where it shows up so clearly. A wide range of practical observations carried out confirm these conclusions. A few examples will be sufficient to illustrate them.

Diesel-Engine Cylinders

Diesel-engine cylinders cast into dried moulds, using pearlitic iron with or without additions (Fig. 6), and which have to be absolutely watertight, are liable to show sponginess at *a*, and often at *b*, if the downgate is placed at a critical distance from the casting. On test, after machining, the castings are often defective; the runner, if too near to the flanges, will heat up the sand between the down gate and the casting, and will give rise to the Léonard effect.

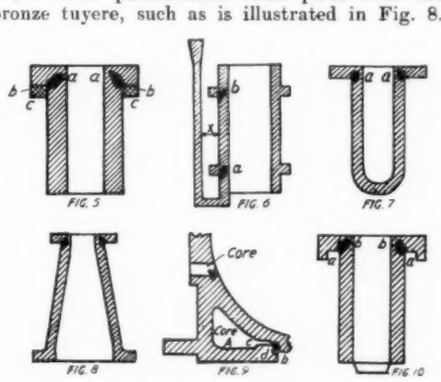
The iron at *b* being cooler, the area around *b* will be spongy or not, according to the temperature of the metal. Simply placing the downgate farther towards the left, that is to say, a reasonable distance between it and the casting, will suffice to eliminate the cause and its effect.

Piston Pot

The casting shown in Fig. 7 will often be spongy at *a*. The heating up of the ring of sand under the flange due to the presence of the mass of metal is the cause of it. A fillet has been put forward for eliminating the sharp angle where the sand is subjected to excessive heating, but this is insufficient to eliminate the porosity. By reducing the angle, the mass of iron from which the heating comes is increased, and the sand is heated up more strongly. The complete elimination of the ring of sand beneath the flange will invariably avoid sponginess at the dangerous areas. This can be accomplished in two ways:—(1) By replacing the sand beneath the flange by a dried-loam cake; or (2) by the use of a chill which will act on the temperature during which the metal passes through the freezing range.

Bronze Tuyeres

The same phenomenon takes place with the bronze tuyere, such as is illustrated in Fig. 8.



Figs. 5 to 10.

The liability of castings to this defect is very great. Quite often the excessive inclination of an ingate forming a too acute angle with the walls of the casting or ingates cut too closely are sufficient to bring about a spongy spot in the metal. By an alteration of the inclination of the ingate by a few degress, or its removal away from it by a few centimetres, the defect is easily eradicated. This applies equally to relatively small castings as for those weighing several tons. The spongy spot can come not only from the sand of the mould, but also from the sand of the core.

Fig. 9 shows a section of a part of a casting for a Diesel engine. The core A made from silica sand, being of a very complicated shape, is in many places surrounded by a more or less large mass of metal. The part C forming a narrow canal is superheated by the metal, the gases forming, having a long pathway to follow

Fig. 4.

take the path of least resistance, penetrate into the metallic mass and invariably form at D a spongy area. Moreover, this action is independent of the degree of the drying of the core. The spongy spot starting at D stops a few millimetres from the external crust. The removal of this crust during machining shows up the sponginess.

A wrong interpretation which visualises the causes of sponginess in the angle of sand formed by the mould suggests the replacement of the angle by a fillet sometimes of a heavy character, which only aggravates the trouble. The increase of the metal mass will bring about a more serious heating up of the core by allowing the gases to act under still slower cooling conditions. By changing the speed during the freezing range of the metal at *e*, the spongy spot was completely eliminated.

A Sleeve Casting

Fig. 10 shows a sleeve for a couple. If it is cast in the position as shown in the diagram and though taking every step in order to suppress the Léonard effect at A but without an upper coreprint for the central core, it often happens that the gases from the core penetrate into B where they form a spongy spot. This spongy spot is shown up after machining. The creation of means for the easy evacuation of these gases will cure this defect.

These few examples, chosen from a number of cases arising from daily practice in the foundry, lend support to the theories outlined as to the probable causes of the formation of spongy spots; they appear to warrant some changes in the outlook which still permeates the foundry, for if in many cases the remedies proposed for avoiding the formation of spongy spots have been both judicious and effective, it can be said of others that every effort has been sterile because of a wrong diagnosis of the chief cause of the defect. It is only by attacking the source of the defect that the effective remedies can be brought to bear. Thus the form of the pattern; the form and position of the runner; the quality of the metal; segregations; casting

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temperature; melting method; and all the other suspect causes can no longer be the direct causes of spongy spots, but only factors which more or less, under certain conditions, favour the appearance of the defect. The principal cause is the Léonard effect, and core gases and all the remedies proposed tend from the practical point of view to suppress or to reduce their action; thus, chills are used to prevent porosity in order not only to prevent "drawn" masses (and in this case it is more a question of hot tears or solidification contraction), but also to suppress in the dangerous areas that protruding portion of sand which induces the effect, and in order to act upon the freezing rate in the vulnerable area by accelerating the formation of a solid crust which is an obstacle to the penetration of gas. The junction of the ribs with the body of a casting is often a spongy area. Not because the ribs "draw" from the mass, but because at the junction of the rib there invariably exists a wedge of sand heated from several sides, and in consequence more fiercely. The avoidance of the rib at the junction or the more rapid cooling of the junction eliminates sponginess. The metal should be completely sound. The quality and the composition of the metal only play a part when causes capable of bringing about the Léonard effect exist, because then the incidence of the length of the freezing range has its effect. Without these causes, all irons behave similarly in regard to spongy spots. It can be imagined that under unfavourable conditions low-carbon-content irons, having a long freezing range, will be liable to exhibit this defect. This liability will be the less, the shorter the freezing range. The best irons from this point of view are those which approach to the eutectic composition. Phosphoric irons can constitute a condition definitely favourable to the existence of the Léonard effect, because of the comparatively low melting point of the ternary eutectic (952 deg. C.). But if the Léonard effect does not exist, then phosphoric iron, other conditions being equal, behaves exactly like either semi-phosphoric or hematite irons. Certain additions of special elements which inhibit spongy spots owe their favourable influence solely to their action on the freezing range, which, by shortening it, render the penetration of the gas from the mould or from the core into the metal more difficult. It can be imagined that under similar conditions the porosity test-piece used for iron has a value determined by a quality of the sand used to form this test-piece. It is the liability of the various sands to set up the Léonard effect—the cause of the spongy spot in the test-piece—which plays a fundamental part, and it is towards a study of this liability that future researches should be directed.

Cupola and Pulverised-Fuel-Fired Furnace Irons Compared

By FR. BOUSSARD

In order to establish a comparison between irons made in the cupola and those turned out from the newer pulverised-fuel-fired furnace, the author has utilised similar charges for the two types of plant.

The analysis of the materials charged was T.C. 3.4, Si 2.3, Mn 0.54 and P 1.27. The casting temperature was reported as roughly 1,400 deg. C. in both cases. As the rotary furnace was run under slightly oxidising conditions, the total carbon came out at 3.24 and the silicon 1.84, whilst the cupola metal gave T.C. 3.45 and the silicon 2 per cent. Naturally, these losses had a profound effect upon the mechanical results obtained. For instance, the life test showed the furnace iron to be slightly inferior to that of the cupola. However, the metal was apparently sounder but, in general, the results were more affected by furnace losses than by any other factor.

The author has apparently been impressed by the excellent results obtained from the electric furnace due to the superheating which is so easily accomplished in that particular type of melting plant.

His next series of tests were so correlated that, after allowing for metal losses, the compositions as obtained from the cupola and rotary furnace were practically the same, but in this series, advantage was taken of the ability to superheat the metal in the electric furnace, and casting temperatures ranging from 1,270 up to 1,500 deg. were utilised. The test-pieces which were cast by these four different temperatures, starting from the same original charge, are set out in Table I.

In the case of sample D, the silicon content was increased by the addition of ferro-silicon. Sample B was maintained for 30 min. between 1,270 and 1,397, C for an hour between 1,270 and 1,457, whilst D was kept for an hour and a half between 1,270 and 1,500.

The oxidation losses are obviously of a low order when the melt is kept at such a high temperature for such a long period. These samples were correlated with life tests, and showed that a maximum life was to be associated with sample C. The small transverse test which was used also showed that the maximum strength must be associated with sample C.

TABLE I.—*Composition and Casting Temperature of Four Rotary Furnace Changes.*

	Casting temperature.	T.C.	Si.	Mn.	S.	P.
A	1,270 deg. C.	3.26	1.87	0.45	0.082	1.30
B	1,397 ,,	3.24	1.84	0.49	0.090	1.27
C	1,450 ,,	3.20	1.75	0.48	0.090	1.27
D	1,503 ,,	3.22	1.87*	0.47	0.097	1.25

* Silicon brought up by ferro-silicon addition.

The above results made the author turn his mind to the question of oxidation, because he found that the addition of ferro-silicon to sample D was all retained in the metal and no oxidation losses were experienced. Thus he started off with a cupola-melted iron containing 2.5 per cent. silicon and added to the cupola spout the ferro-silicon additions. The results are shown in Table II.

TABLE II.—*Influence of Silicon on Final Silicon Content of Cupola Metal.*

Quantity of Si added.	Final result.
No ferro-silicon	2.5
0.1	2.5
0.2	2.5
0.3	2.6
0.4	2.75

From this it appears that up to 0.2 per cent. of silicon as ferro-silicon there is no noticeable increase in the silicon content of the iron, and thus it is assumed that the addition of 0.2 per cent. is necessary to eliminate the oxidation, which is presumed to be present. The author remarks that this practice of adding 0.2 per cent. of silicon to the ladle as ferro-silicon is a worth-while addition and recommends this practice. The fact that rotary furnace is in equilibrium is a point in its favour.

Sound and Unsound Steel Castings

By JEAN OBREBSKI.

[POLISH EXCHANGE PAPER.]

The author's definition of "unsound" ("malade") is not the comprehensive term such as is understood in the English language, but is restricted by him to mean a type of intergranular weakness; the abstractor regrets his inability to find a technical term corresponding to the author's word "malade," unless it be "intergranular weakness." According to the author, the first symptom of this unsoundness is a lack of improvement in a steel casting by reheating, followed by normalising. With a fairly good tensile strength, very poor elongations are obtained, practically as low as in the "as-cast" condition. The reduction of area is also low, or is completely absent. It seems desirable to note that an apparently good tensile strength is an illusion. Inter-crystalline cracks are naturally to be associated with conditions where the adhesion between the various crystalline elements is weak or non-existent. When there is no adhesion in extreme cases, there are definite inter-crystalline cracks. Following on this line of thought, the author has set out the following scale for the defects related to the cohesion of metal:—

(1) Total lack of cohesion—microscopic draws.

(2) Very feeble cohesion. The crystalline elements are separated by small blowholes and often by non-metallic inclusions.

(3) Weak cohesion—neither blowholes nor non-metallic inclusions are clearly visible—the faces of the crystals are smooth.

(4) Good cohesion—nevertheless insufficiently so for preventing the metal from dividing itself between the crystals.

(5) Very good cohesion—the crystalline appearance of fractures only appears at a few points.

(6) Perfect cohesion—normal fracture as one associates with forged or rolled steel of good quality.

After elaborating the above scale at some length, the author draws a number of conclusions from which we have picked out the following as being of major importance:—

Latent intercrystalline cracks (lines of least cohesion) favour the congregating of the ferrite along the intercrystalline boundaries. Heat-treatment followed by normalising is not always sufficient to compel the ferrite to leave these boundaries. Taking the above generalisation for granted, it must be admitted that if, after a thermal treatment thoroughly carried out, a system of ferrite, following the crystalline boundaries is still found, such a casting can be defined as unsound (malade). If the annealing be sufficient to disperse the system, the casting can then be designated "sound."

Practical conditions demand answers to the two following questions:—(1) What are the causes of cracks, latent cracks, in cohesion between crystals? and (2) How to avoid these defects? In general, these questions are not solely confined to steel castings, but are equally a matter for other alloys utilised in foundry practice. To reply completely and with certainty to these two questions would advance foundry technique very considerably. Personal suggestions are put forward in the following statement. The factors which appear to favour most the appearance of intercrystalline weakness in castings are as follow:—(1) An excessively slow solidification; (2) too high a content of dissolved gases in the liquid metal; (3) chemical disequilibrium, that is, incomplete reactions still being carried out in the ladle and in the mould which cause the appearance of occluded gases and the formation of non-metallic inclusions; (4) too great a difference between the temperatures at the start and at the finish of solidification; and (5) insufficient deoxidation.

A Study of the Machining Problem with Particular Reference to Cast Iron

By H. H. BEENY, M.Met.

[British Exchange Paper.]

There are four aspects of the machining quality of a metal, which are:—

(1) *The Cutting Speed with a Given Type of Cutting Tool.*—This is related to the amount of metal which can be removed per minute, and varies greatly in different metals; thus, using the latest sintered tungsten-carbide tools, chilled chromium-bearing white cast iron with a Brinell-hardness number of over 500, can be machined at approximately 15 ft. per min., whereas phosphor-bronze and gun-metal are regularly cut at 2,000 ft. per min. and aluminium alloys, with suitable equipment, have been dealt with at 7,000 ft. per min.

(2) *The Life or Endurance of the Cutting Tool.*—This depends largely upon the tool itself and is related to the cutting speed employed as well as to the qualities of the metal.[1] Some metals are naturally abrasive or have a high degree of tensile strength which causes heavier cutting pressures; excessive ductility, by allowing the metal to pile up in front of the tool, can also produce a severe lapping action on the cutting edge.

(3) *The Finish on the Machined Surfaces.*—This is sometimes important on account of appearance or because rough surfaces tend to wear more quickly than smooth, and, again, because in certain cases service stresses are localised by bad machining marks.

(4) *The Power Consumed by the Tool or Machine in Making the Cut.*—This varies greatly with different metals with the same cutting speed and cross-sectional area of cut; thus, it has been found that machining a 0.40 per cent. C. steel, with a tensile strength of 45 tons per sq. in., absorbed 84 per cent. more horse-power than a good-quality grey cast iron with a Brinell-hardness number of about 200. In general the strong ductile metals, such as steel, nickel and Monel Metal, form a tough continuous type of chip which absorbs much power, whereas lower tensile and less ductile metals, such as grey cast iron, aluminium alloys and bronze, bend or break away readily in front of the tool.

As has been pointed out by E. G. Herbert,[2] the cutting data obtained, in any particular case, depend not only upon the metal being cut, but also upon the properties and design of the tool and machine in which the operation is conducted, so that it is clear that the "machinability" of a metal cannot be determined in a simple manner, and for that reason there is the need for a more general study of the factors involved.

Fig. 1, taken from Mr. Herbert's work,[3] illustrates what happens in the early stages when a cutting tool forces its way through the metal, and it is apparent that with ductile or semi-ductile materials the chip is prised or torn from the body of the metal by complex tensile, compressive and shearing forces. The preponderance amongst these forces depends upon the type and strength of the chip, and also very largely upon the cutting angles of the tool. It is clear that tools with a large "top rake" tend to prise or lift the chip from the metal and exert mainly a tensile force, whereas "blunt-angled" tools tend to push the metal off under compression and shear.

Metallurgical Aspects of Machinability

The metallurgical properties of metals which affect machining quality in various degrees are as follow:—

Chemical Composition. — Composition has a fundamental influence upon all other properties, but it can also have a direct effect upon abrasion; as an instance, aluminium alloys, in general, can be machined at very high speeds with but little wear on the tool, but those containing about 14 per cent. of silicon have a tremendous abrasive action, due to the extremely-hard minute plates of crystalline silicon scattered throughout the metal. Low Brinell hardness is no indication of the machining quality in this and other similar cases.

Physical Structure. — Microscopical methods are usually employed and frequently bring to light abrasive constituents or inclusions such as small particles of slag, alumina, sand or other oxide materials, which would be missed by ordinary chemical analysis. In cast irons, the texture and form of the graphite flakes and the phosphide eutectic can be studied along with the amount and condition of the combined carbon. This type of test appears particularly valuable in regard to cast iron.

Static Strength.—This property can be determined in a reliable way by the tensile test, and

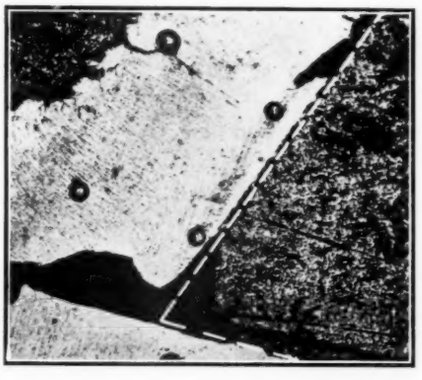

Fig. 1.—Early Stages of Chip Formation showing Crack Running Ahead of the Tool. × 25. (E. G. Herbert.)

Dotted Lines have been added to indicate the Shape and Position of the Cutting Tool.

it is obvious when one studies the mechanism of chip formation that such a measurement is of very great importance, as the actual cohesion between the particles of the metal largely controls the pressure set up on the nose of the tool. This, in turn, influences the amount of frictional heat and wear, which together tend to soften and destroy the edge of the tool. It is well known that the tensile strength is used to estimate the permissible cutting speed for steels and even with a brittle material such as cast iron experience shows that the tensile strength can be used in a broad way to indicate the probable behaviour in machining.

It is found for metals generally that low tensile strengths, unless associated with undue ductility, favour rapid machining or, in other words, high-cutting speeds and heavy cuts, as there is not the same tendency to overheating or breaking of the cutting edge as with high tensile materials.

Brinell or Indentation-Hardness Number.—This very simple form of test is undoubtedly a rough qualitative guide to the machining of metals in general. A low Brinell hardness usually favours rapid and easy machining, but there are exceptions, as when a metal is definitely abrasive due to surface or internal conditions, or is associated with excessive ductility.

Ductility.—Ductility, which may be estimated from a tensile test, is very important, as it determines, in the first place, whether the chip is continuous or broken, and this, in turn, largely decides the amount of top rake required in the cutting tool. The power required is also affected, as a continuous ductile chip absorbs more energy than the short broken chip from a brittle metal. Low ductility favours rapid and easy machining, but considerable ductility when provided for by the shape of the tool and type of cut does not cause clogging or dragging and, therefore, does not usually create machining difficulties. Grey cast iron possesses no ductility and is of very moderate tensile strength, so that robust angled tools can be used and the machining problem is greatly simplified.

Dynamic Strength.—Impact tests of the Izod or Charpy type measure the resistance of the metal to the propagation of cracks under rapid-loading conditions, and, therefore, must bear some relation to machining quality. In steels, it is known that an increase in the phosphorus which enters into solid solution in the matrix of the metal greatly reduces the impact strength and at the same time aids machining. Low impact strength favours easy machining if accompanied by only moderate hardness and static strength. It is known that the impact strength of grey cast iron is very low, but a difficulty exists in finding a suitable form of test to measure this quality.

Work-Hardening Qualities. — Certain steels, and particularly those of an austenitic nature, are capable of severe work-hardening, so that special care has to be taken during machining to minimise deformation of the chip and prevent "glazing" of the metal; cast iron, being brittle and of low tensile strength, breaks away before appreciable plastic deformation can take place and thus avoids these difficulties.

Frictional Properties. — This characteristic is mainly of importance when heavy pressure and heat are developed between the chip and the tool; it does not play much part in the machining of cast iron. Cast iron does not adhere to the edge of tungsten-carbide tools, whereas soft steels do adhere and tear out the minute particles of hard carbide so that a crater is gradually developed which finally causes the cutting edge to chip. Alteration to the composition of the hard-carbide material is necessary to improve the frictional property and overcome this tendency.

The effects of the foregoing metallurgical factors upon machining can be summed up broadly by stating that low tensile strength and Brinell hardness number, combined with minimum ductility and impact resistance, favour the highest cutting speeds and heaviest cuts or, in other words, the most rapid rate of metal removal. These low qualities may be inherent, or be due to the continuity of a strong matrix being broken up by weak and non-abrasive particles, such as the graphite flakes in pearlitic cast iron. Provided inclusions and isolated constituents of a hard and abrasive nature are absent, as far as possible, both from the body and the skin of the metal, such conditions by reducing pressure and friction between the chip and the tool also give minimum tool wear. The greater the general strength and ductility of the metal, however, the more serious would be the abrasive action of hard particles, as they would press against the face and edges of the tool with more force. On the other hand, if, at the same time such particles also weakened the metal, as is shown later in the case of phosphorus in cast iron, conditions are more complex.

The physical texture and soundness are important, as they not only affect the tensile strength of metals but also have a controlling influence upon the uniformity of the machined finish. This is particularly true of cast iron, as a coarse, open structure causes particles of metal

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to be torn from between the graphite flakes and so accentuates the roughness and appearance of porosity.

The Machining Qualities of Grey Cast Iron

Grey cast iron is low in tensile strength, ductility and impact resistance, and can be produced with a more or less uniform structure. It machines with a short chip which breaks away freely in front of the tool without setting up sufficient pressure to cause work-hardening in the metal, or "building-up" on the cutting edges; in addition, on account of the low tool pressures and the good frictional properties, which are aided no doubt by the presence of graphite flakes, there is a minimum development of frictional heat. These are favourable circumstances, but nevertheless machining speeds for grey cast irons are low in comparison with other alloys of similar strength, such as gunmetal and aluminium, and the wear of the tools much heavier.

One reason for the reduced machinability is the fact that it is customary to machine the metal dry on account of the fine metallic dust which is produced and soon contaminates any cutting oil or emulsion circulated by the machine. A satisfactory cutting fluid helps to lubricate the movement of the chip and the work against the cutting edge, and so tends to reduce tool wear, but more important is the refrigerating action which enables higher cutting speeds to be attained without overheating the cutting tool. It is clear that the general absence of cutting fluids does much to account for the machining position of the alloy, but, in addition, iron castings possess a severe abrasive quality, due, in the first place, to sand, scale, metal shot and chilled areas, at or near the skin, and in the second place to hard constituents within the metal, such as iron carbide and phosphide.

It was noticed, in making drilling tests, that passing the drill through the skin of a grey-iron casting produced measurable blunting, whereas many holes could be drilled through the interior metal without noticeable alteration in the cutting efficiency. It is the practice in the workshop to take a deep cut so as to get the cutting edges of the tool as much as possible beneath the skin of the casting and so minimise the abrasive effect, but even so efficient fettling is important.

The graphite flakes in cast iron, by weakening the matrix, very greatly facilitates rapid machining, but it is inadvisable to increase their size and number by raising the total carbon, as this would deteriorate the mechanical properties of the metal, and at the same time, owing to the coarse porous structure, would cause the machined finish to be unsatisfactory. Most irons are cupola melted, and usually not much variation in the total carbon is possible, but it has been stated that for any given strength better machinability is obtained by a low total-carbon–high-silicon iron than by one of the high total-carbon–low-silicon type,[4] and for reasons given later the author feels himself in agreement with that opinion.

Influence of Carbon on Machinability

Combined carbon in the massive form as free cementite (Fe_3C) occurs in white irons and in the chilled areas of grey-iron castings, and is obviously very detrimental to tool life, as the constituent has a Brinell-hardness number of approximately 550; it is interesting to note, however, that sintered-carbide tools can deal satisfactorily with white irons previously not commercially machinable, and also enables stronger grey-iron mixtures to be dealt with without difficulty and at much increased speeds.

In grey irons, combined carbon below about 0.85 per cent. exists not as free or massive cementite, but as a constituent of the pearlite, which is illustrated by Fig. 2. As is well known, this constituent consists of minute alternate layers or lamellæ of hard, brittle, iron carbide and soft, tough, carbon-free iron. It occupies a very large volume, so that most foundry castings have a more or less completely pearlitic matrix. The tool has to cut its way *through* this structure—it cannot merely cut *between* the hard layers or push them away, as is largely the case when a hard constituent exists as isolated particles imbedded in a softer matrix. Pearlite exists in a similar form in annealed steels, and,

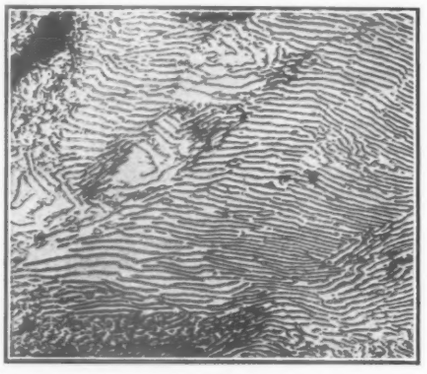


FIG. 2.—LAMELLAR STRUCTURE OF PEARLITE IN CAST IRON (PRIMROSE). × 500.

with increasing amounts, greatly reduces cutting speeds as well as intensifying the abrasion of the tools. The striking effect of this constituent on grey cast iron is illustrated by Table I, which is compiled from an investigation made in the machine shop some years ago on account of great differences in the turning quality of apparently

TABLE I.—*Influence of Pearlite on Cutting Speeds.*

	Sample No.			
	1.	2.	3.	4.
Total carbon, per cent. ..	3.23	2.97	2.95	2.99
Silicon, per cent.	1.46	2.59	2.33	2.59
Combined carbon, per cent.	Trace	Trace	0.65	0.60
Cutting speed, ft. per min.	117	115	44	48
Depth of cut in in. ..	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{16}$
Feed, cuts per in. ..	21	28	69	70
Dia. of work in in. ..	$8\frac{3}{4}$	8	7	9

similar castings. It was found that certain of the castings had been subjected to a full annealing treatment, and the removal of the combined carbon in this way had practically trebled the permissible cutting speed, doubled the feed and prolonged the working life between grinds of the high-speed-steel tools from approximately one

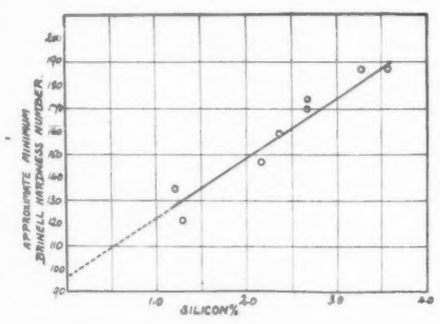


FIG. 3.—VARIATION OF BRINELL HARDNESS WITH SILICON CONTENT IN FULLY-ANNEALED CAST IRONS.

hour up to from four to six hours. The annealing treatment consisted of heating for four hours at 850 deg. C. and cooling slowly in the furnace to a black heat. All the irons contained approximately 0.6 per cent. manganese, 0.090 to 0.11 per cent. sulphur, and from 0.80 to 1.00 per cent. phosphorus.

In dealing with good-quality irons, it is necessary not to overlook that an annealing treatment which converts the combined carbon to graphite at the same time reduces the mechanical strength and wearing quality of the iron. General opinion was divided in regard to the exact requirements to give maximum wear resistance, but experience in the machine-tool trade, and also the bulk of published data,[5] support the view that a full amount of pearlitic carbide is desirable in grey cast iron to ensure the best-wearing quality under practical conditions.

The strong low-silicon irons depend mainly for their superior mechanical and wearing properties upon the high proportion of pearlitic carbon they contain, and it has been clearly demonstrated[6] that such irons suffer more loss in tensile and transverse strength and Brinell hardness by annealing than do the weaker high-silicon type, and full annealing should, therefore, be applied to the better irons with great reserve. To sum up the effect of combined carbon, it can be stated that for most purposes where quality counts and when special low total-carbon irons are not used, the best compromise is given by an iron containing from 0.60 to 0.85 per cent. of combined carbon, as this amount gives a more or less completely pearlitic matrix with maximum strength, good wearing and practicable machining qualities.

Influence of Sulphur and Manganese

Manganese and sulphur are always found in small proportions in cast iron, and if properly balanced combine together to form manganese sulphide, which appears as soft, weak and non-abrasive globules scattered through the body of the metal. Its effect is masked by other constituents such as graphite flakes and combined carbon, but it can be taken that manganese sulphide aids rather than hinders machining. If there is an undue excess of either manganese or sulphur, then the combined carbon is altered, and on account of this the machining quality is different.

Effect of Silicon

The effect of silicon upon machinability is very important, and is complicated by the fact that it not only influences the amount of combined carbon present, but also enters into solid solution and has a hardening and embrittling action upon the iron. Unless oxidised the element does not form a separate physical constituent and produces no direct abrasion. The hardening effect of silicon in the absence of combined carbon is illustrated by Fig. 3 from some earlier work by the author.[6] Good-quality machinery irons of varying silicon content were fully annealed and then Brinell tested, and it was seen that the Brinell hardness increased rapidly with increasing silicon and accounted for the fact that the so-called "soft" irons, containing 3 per cent. of silicon and naturally having but little combined carbon in the "as-cast" state, frequently gave a higher Brinell figure than lower silicon irons which possessed much more combined carbon and were more difficult to machine.

The second and much more important effect of silicon is due to its controlling influence upon the amount of combined carbon in the casting. Table I illustrates the marked effect of combined carbon on machinability, but does not separate the two types of action due to silicon. A further test, using a drilling machine, was, therefore, made on pairs of round bars with varying silicon contents and suitably adjusted diameters, as detailed in Table II. One bar of each pair was tested in the "as-cast" condition (C) and the other after a full-annealing treatment (A), which consisted of heating for four hours at 850 deg. C. followed by slow furnace cooling to a black heat, the drop from 800 deg. C. to 650 deg. C. taking three hours. It proved very difficult to remove the whole of the combined carbon from the lowest silicon iron,

but it was noted by microscopical test that the remaining pearlite had been spheroidised so that it would have a minimum effect upon machining. The manganese and sulphur contents of all the irons were similar at about 0.60 and 0.10 per cent. respectively, but, as reported, there was some variation in the percentages of total carbon and phosphorus. Apart from these minor differences, the annealed bars were capable of indicating the specific action of silicon upon the drilling quality, and the "as-cast" bars this specific action, plus the effect of the concurrent variation in the combined carbon content of the irons.

TABLE II.—*Influence of Carbon, Silicon and Heat-Treatment on Machinability*

Grade.	P.		L.		H.		S.	
T.C., per cent.	3.17		3.27		3.42		3.55	
Si, per cent.	3.10		2.70		1.83		1.08	
P, per cent.	1.04		0.96		0.74		0.47	
Dia. as cast, in in.	0.875		0.875		1.20		2.20	
Condition*	C.	A.	C.	A.	C.	A.	C.	A.
Penetration, in in., per 500 revs. 1	0.435	0.480	0.460	0.515	0.355	0.491	0.309	0.502
Penetration, in in., per 500 revs. 2	0.425	0.470	0.468	0.515	0.352	0.488	0.300	0.488
Average penetration, in in., per 100 revs.	0.086	0.095	0.093	0.103	0.071	0.098	0.061	0.099
C.C., per cent.	0.40	Nil	0.45	Nil	0.67	Nil	0.92	0.20
Brinell hardness No.	229	174	229	174	217	146	187	134

* "As cast" denoted by C, and annealed by A.

Drilling Machine Tests

The drilling machine, illustrated by Fig. 4, was designed a number of years ago but did not give consistent results with the older types of drills. Fresh tests were made with "Ardoloy" tipped drills made from the super-hard sintered tungsten carbide material, and it was found that a large number of tests could be made without regrinding owing to the high resistance to abrasion possessed by suitable grades of this alloy. The slow spiral ½-in. dia. drill (D) used is held in the spindle of the machine, which is capable of lateral as well as rotational movement, and is forced against the cast iron sample mounted in the chuck (C) by a wire passing over a pulley wheel on the back end of the spindle and supporting a weight (W) of 51 lb. The drill is rotated at 1,370 r.p.m. which corresponds to a peripheral speed of 180 ft. per min. the total number of revolutions and depth of penetration are recorded autographically on the drum (R). The wire carrying the weight (W) passes over the spindle of the drum and by its movement measures the depth of penetration of the drill into the sample. Before making the actual test the drill is sunk in below the level of the lip, but no hole of smaller diameter was first made in the sample to accommodate the centre of the drill owing to the tendency to set up a dangerous vibration.

The samples were drilled in a certain order and the order then exactly reversed so that two tests were made on each sample; the depth penetrated by 500 revolutions of the drill was taken as a measure of the machinability, and by adding the two results together compensation was made for any slight wear of the cutting edges. As a matter of fact, very close agreement was obtained on each sample; the averaged results were finally calculated to penetration in inches per 100 revolutions of the drill.

The figures in Table II on the annealed bars indicate that silicon did not directly cause decisive alteration in the penetration value, although the Brinell hardness number was increased from 134 to 174. On the other hand, in the "as-cast" bars there is a marked gain in penetrability with increasing silicon which is clearly due to the concurrent fall in the combined carbon. Above 2.7 per cent. silicon, however, the depth of penetration diminishes slightly in both the "as cast" and annealed samples due, possibly, to the hardening effect of the silicon in solid solution in the matrix. The Brinell numbers do not entirely reflect this hardening action as the highest silicon metal (grade "P") had to be cast at the same diameter as the grade marked "L" in order to allow sufficient width of section for a ½-in. dia. drill, and consequently the structure will be slightly more open in texture. The marked effect of combined carbon is confirmed by the large differences in penetration between the "as cast" and annealed bars which show up particularly on the grade "S" metal.

From the tests it seemed that a silicon of about 2.70 per cent. in a suitable section will give the best machinability for the types of iron dealt with, and this conclusion was in agreement with observations on various types of cutting in the machine shop, as it is found that machining difficulties most frequently arise either in the comparatively high-tensile—low-silicon irons or in the highest silicon irons (over 3.00 per cent.), which had a low-tensile strength but a Brinell hardness number frequently as high as 255.

The Brinell hardness numbers of grey cast irons do not show much variation in the "as cast" state as the softening effect of the reduction in the amount of combined carbon in the higher silicon irons is usually more than balanced by the hardening action of the silicon itself in solid solution. It is, therefore, quite definite that Brinell hardness numbers alone cannot be expected to indicate the relative machinability of grey cast irons. The test will, however, distinguish between the "as cast" and fully annealed conditions when the compositions of the irons are roughly known, and it will, in addition, detect unduly hard metal or chilled areas, and is thus very useful for quick investigations in certain cases.

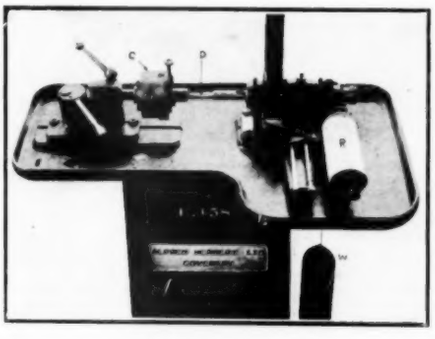


FIG. 4.—DRILL PENETRATION-TESTING MACHINE.

Effect of Phosphorus

Phosphorus combines with iron to form the phosphide, Fe_3P, which is hard and abrasive and appears in grey foundry irons as a constituent of the "phosphide eutectic" (steadite). The amount of this element varies considerably in the irons detailed in Table II, and further tests were made on round bars cast in sand at 1.2 in. dia. by 21 in. long, to which phosphorus was added by means of ferro-phosphorus. The base metal was a low-sulphur and low-phosphorus refined pig-iron and the actual analyses obtained are given in Table III. The sulphur contents varied a little, due mainly, no doubt, to the dilution of the cupola-melted base metal with ferro-phosphorus, but as sufficient manganese was present the sulphur would exist as manganese-sulphide, and no appreciable alteration would be expected in the machining quality. The slight drop in combined carbon with increasing phosphorus can be explained simply by the extra volume taken up by the steadite in the eutectoid matrix.

Two bars from each grade were annealed by soaking at 850 deg. C. for five hours, cooling in three hours to 720 deg. C. and holding at this temperature for ten hours before furnace cooling to a black heat. The operation was conducted in a large electrically-heated furnace with automatic temperature-control equipment, and the prolonged treatment was decided upon after preliminary tests which revealed a much greater stability in the combined carbon in the lowest-phosphorus metal than in Grades 2 and 3. Grade 4 was intermediate in behaviour. The annealing treatment given above still left a small amount of combined carbon in the Grade 5 metal which was thoroughly spherodised, however, and thus would have a minimum effect upon machining behaviour. The moderately low silicon will explain considerable carbide stability, but the reason for the difference was not clear unless due to the phosphorus itself. A preliminary series of bars cast with varying phosphorus revealed exactly the same feature, and it is interesting to note that two Russian workers record that phosphorus increased the growth of cast iron by facilitating cementite breakdown.[1]

TABLE III.—*Composition of the Phosphorus Series.*

Grade.	2.	3.	4.	5.
T.C.	3.23	3.27	3.30	3.34
G.C.	2.48	2.46	2.49	2.47
C.C.	0.75	0.81	0.81	0.87
Si	1.46	1.46	1.44	1.46
Mn	0.61	0.65	0.63	0.67
S	0.068	0.089	0.084	0.117
P	1.58	1.07	0.68	0.34
Ti	0.07	0.06	0.03	0.02

Tensile, Brinell and drill penetration tests were made on both the "as-cast" and annealed bars, and the results are reported in Table IV along with the phosphorus and combined-carbon percentages. No impact figures were included as it was difficult to find a satisfactory form of test. A new and harder ½-in. dia. sintered tungsten-carbide drill was used for these drilling tests, so that the values are not directly comparable with those in Table II. Otherwise the same system of testing was employed as previously described.

In the "as-cast" bars increasing phosphorus diminishes the amount of combined carbon slightly, increases the Brinell hardness, and causes a serious loss of tensile strength. The drilling results, which were repeated several times, established that the Grade 5 metal, with its 0.34 per cent. phosphorus, was definitely the hardest to cut. This is to be expected on account of the high tensile strength, and it is interesting to note that planing speeds on production with the same type of iron, when using sintered tungsten carbide tools, had to be permanently reduced to approximately 100 ft. per min. in order to get a satisfactory tool life.

Metal previously used which machined at 180 ft. per min. contained approximately 3.35 per cent. total carbon, 0.75 combined carbon, 1.60 silicon, 0.60 manganese, 0.11 sulphur

and 0.85 per cent. phosphorus, and had an average tensile strength of 14 to 15 tons per sq. in. It seemed clear that low phosphorus reduced the rate of metal removal by increasing the tensile strength of the iron. The phosphide eutectic usually existed as more or less isolated lakes, which evidently lowered the cohesion between the grains of the metal and thus allowed a crack to spread more easily in front of the cutting tool. The annealed bars (Table IV) are greatly weakened by the loss of the combined carbon in the pearlite grains surrounding this eutectic and by the enlargement of the graphite flakes, so that phosphorus variations exert

TABLE IV.—*Influence of Phosphorus on Machinability.*

Grade.	2.		3.		4.		5.	
P, per cent.	1.58		1.07		0.68		0.34	
Condition*	C.	A.	C.	A.	C.	A.	C.	A.
Penetration, in in., per 500 revs. 1	0.454	0.744	0.472	0.695	0.460	0.680	0.418	0.712
Penetration, in in., per 500 revs. 2	0.458	0.744	0.454	0.705	0.462	0.704	0.422	0.724
Average penetration, in in., per 100 revs.	0.091	0.149	0.093	0.140	0.092	0.138	0.084	0.144
C.C., per cent.	0.75	Nil	0.81	Nil	0.81	0.02	0.87	0.12
Brinell No.	262	149	248	143	235	143	235	140
M.S., tons per sq. in.	11.60	8.56	12.92	9.72	13.28	9.32	17.64	10.32

* As cast denoted by C, and annealed by A.

but little effect upon either the tensile strength or the depth of drill penetration. The Brinell hardness numbers also do not vary appreciably as the steel ball was able to push the hard and brittle phosphide particles into the soft and yielding ferritic matrix.

With very high phosphorus contents it is possible that tool wear, which is not estimated, would be increased owing to the large amount of hard eutectic present, but in any case, such increase would be much less than that which would take place with a ductile metal giving a continuous chip. On account of possible tool wear, however, it appears that about 0.80 per cent. phosphorus would offer the best combination of machining properties for unannealed castings, while avoiding drastic reduction of the tensile strength. The tests also indicate that low phosphorus should be avoided with medium and low silicon irons, on account of the increased stability of the pearlitic carbide.

Table IV lends support to the conception that tensile strength might exercise a decisive influence on the machining of grey cast irons, but as a check, further tests were made by the same method on 1.2-in. dia. test-bars, cast in sand, which varied in tensile strength from 11.60 to 24.68 tons per sq. in. Particulars of the irons with the drilling tests are given in Table V.

TABLE V.—*Showing Relation Between the Tensile Test and Machinability.*

Grade.	A.	C.	D.	5 (C).	2 (C).
T.C., per cent.	3.17	2.96	3.15	3.34	3.23
C.C., per cent.	0.74	0.75	0.62	0.87	0.75
Si, per cent.	1.34	1.81	1.95	1.46	1.46
P, per cent.	0.12	0.17	0.47	0.34	1.58
M.S., tons per sq. in.	24.68	23.16	18.48	17.64	11.60
Penetration in in. per 500 revs. 1	0.355	0.365	0.428	0.415	0.458
Penetration in in. per 500 revs. 2	0.357	0.375	0.432	0.432	0.480
Average penetration in in. per 100 revs.	0.071	0.074	0.086	0.085	0.094

The samples "5 (C)" and "2 (C)" were from the same bars as those used for Table IV, and it will be noticed that the drill penetrations agreed well. The bars marked "A," "C" and "D" are from grades of special high-tensile cast iron. In addition to the compositions given in the Table, these three bars contained approximately 0.15 per cent. sulphur with 0.58 per cent. manganese, but were free from all but traces of nickel or chromium. The combined carbon percentages were moderately similar, but, as might be expected, the high tensile irons were very low in phosphorus. The series extended the range of phosphorus contents covered by the tests. The rate of penetration, or ease of machining, increased with falling tensile strength with a slight exception in the case of iron "5 (C)," which possessed the highest combined carbon, and it was clear from these tests, as well as those in Table IV, that tensile strength exerts a critical influence upon machinability. It is further evident that the main significance of phosphorus in grey cast irons containing substantial amounts of pearlite is due to the detrimental effect which phosphorus had on the mechanical strength.

Time has not permitted the investigation of special alloy cast irons or of those which had been quenched and tempered, but it seems safe to assume that the general effect of alloying elements or of special heat-treatments will depend upon their influence on the amount and form of the combined carbon and upon the ultimate tensile strength of the metal. A modification of the normal lamellar structure of the pearlite by these means will obviously introduce a new factor; thus spheroidising of lamellar pearlite is known to improve machining quality whereas the formation of martensite or tough forms of sorbite will impede machining.

REFERENCES.

1 "The Art of Cutting Metals," by F. W. Taylor. Book published by The American Society of Mechanical Engineers in 1906, December, p. 159.
2 "The Problem of Machinability—Measurement," by E. G. Herbert, "Metallurgia," 1930, September, p. 169.
3 "Machinability," by E. G. Herbert, "Proceedings of The Inst. of Mech. Engineers," No. 4, 1928, Fig. 2.
4 "Symposium on Cast Iron," "Proceedings of American Society for Testing Materials," vol. 33, part 2, p. 128.
5 "The Wear of Cast Iron," by F. K. Neath, FOUNDRY TRADE JOURNAL, 1933, March 23, pp. 203–205.
6 "The Annealing of Cast Iron," by H. H. Beeny, FOUNDRY TRADE JOURNAL, 1929, March 28, pp. 229–331, and April 4, pp. 251–253.
7 "The Influence of Silicon, Phosphorus and Manganese on the Growth of Cast Iron," by I. Fetchenko-Tchopivski and S. Novosielski. (Hutnik, 1933, vol. 5, pp. 176–190). Abs. "J.I.S.I.," 1934, vol. 2, p. 638.

Conclusions

The main conclusions to be drawn in regard to the machining of cast iron are as follow:—

(1) Grey cast iron is low in tensile strength, impact resistance and ductility, and, therefore, machines readily with a short chip. The metal is usually machined dry and possesses severe abrasive qualities due to the condition of the skin and to the combined carbon content. Cutting speeds are not, therefore, as high as with other metals of similar strength and greater ductility, such as gun-metal, medium-quality phosphor bronze and aluminium alloys. Tool wear with grey cast iron is also very much more rapid, due to the severe heat and abrasion. Tool stresses, however, are low in comparison with such materials as the steels, and the new sintered carbide alloys with their great hardness and resistance to heat are, therefore, pre-eminently suitable for use on cast iron and have, in fact, become the standard tipped-tool material for this metal. Such tools permit from three to five times the weight of metal to be removed in a given time, due to increased cutting speeds, than was possible with high-speed steels. Even with these tools castings should be well fettled and cuts should be arranged so as to avoid abrasion by the skin as far as possible.

(2) The important active constituents in grey cast iron are:—

(*a*) *The graphite flakes*, which break up the continuity of the metallic matrix and, therefore, facilitate machining.

(*b*) *The combined carbon both massive and pearlitic.*—Massive carbide as chilled or hard spots obviously impede machining. In grey irons pearlitic carbide exercises a very marked retarding effect upon machining, because pearlite is both strong and tough and is disposed throughout the casting in such a way that the constituent had to be actually cut or torn by the passage of the tool. Silicon does not exercise much direct effect upon machinability, but is important owing to its control upon the amount of combined carbon found in a casting of given section. Silicon, by rendering the pearlitic carbide unstable, facilitates rapid annealing.

(*c*) *The "Phosphide eutectic."*—Phosphorus in this form exercises an influence upon the machining of unannealed grey-iron castings due to the reduction in tensile strength which its inclusion causes. It lowers the cohesion between the grains of the metal and, therefore, assists machining as the metal breaks more easily away in front of the tool. In a brittle metal such as cast iron, which gives a short chip, the hard particles are not pressed against the edges of the tool as with a continuous chip from a ductile metal, and, therefore, the destructive action due to abrasion by the hard particles is minimised. Nevertheless, in the absence of appropriate tests it seems desirable to avoid very high phosphorus irons. Phosphorus in medium- and low-silicon irons decreases the annealing time required by reducing the stability of the pearlitic carbide. The actual tests are conclusive in this respect, but further confirmation is desirable as the sulphur and titanium contents of the irons varied somewhat (Table III). In annealed irons the metal surrounding the phosphide lakes is greatly weakened and phosphorus does not then materially alter the rate of machining.

(3) Apart from skin conditions, combined carbon and tensile strength are the ultimate factors which might control the machinability of grey cast irons whether "as cast" or annealed. A tensile test summarises the effect of a number of factors, such as the general composition, the form and number of the graphite flakes, the soundness and the rate of cooling of the casting. It is clear that for any given tensile strength, the lower the combined carbon, the better is the machining quality. For this reason low total carbon-high silicon irons, which contain less combined carbon, will machine better than high total carbon lower silicon types of equivalent strength, as the latter require a fuller proportion of pearlitic carbon to maintain this strength.

(4) For maximum machinability castings must be fully annealed as this treatment reduces both the tensile strength and the combined carbon to the greatest extent. Here, again, the low total carbon-higher silicon type of iron is of advantage as effective annealing can be obtained in a shorter time, due to the greater instability of the combined carbon. For the same reason the tests show it to be important to use medium- or high-phosphorus contents. The higher the silicon the less would be the need for phosphorus to decrease the stability of the carbide.

(5) Rapid machining and high engineering quality are to some extent opposed, but as a reasonable compromise and, considering also tool life and surface finish, the following composition

appears the best for the machining of unannealed castings and also those which have to be annealed:—T.C., 3.00 per cent.; C.C., 0.45; Si, 2.70; Mn, 0.50; S, 0.10, and P, 0.80 per cent. The combined carbon will naturally vary with the section and adjustment of silicon will have to be made, but up to about 3.0 per cent. the highest silicon should be used which will produce a sound casting. Heavy castings are the most difficult problem as, with the low silicon, the carbides are very stable and a low-phosphorus content is sometimes necessary in order to avoid porosity.

In conclusion the author wishes to express his appreciation to the directors of Messrs. Alfred Herbert, Limited, machine-tool makers, Coventry, England, for permission to publish the Paper, and to Mr. H. Booth, works manager, for his advice on matters relating to the cutting of metals. He would also like to thank Mr. W. G. Morgan, of the foundry department, for co-operation in producing the test-bars, Mr. F. A. Neason for the chemical tests and Mr. W. L. Smith for work in connection with the drilling tests and the preparation of photographs and slides.

The Production and Utilisation of Virgin Irons Containing Titanium and Vanadium

By JEAN CHALLANSONNET.

[Extract.]

The author has dealt with the irons available to commerce which, naturally, contain varying quantities of nickel, chromium, titanium and vanadium, the best known of these being the Mayari brand of iron, which has been exploited for many years by the Bethlehem Steel Company of America.

The author deals in some detail with an iron manufactured at Bremanger, in Norway. This iron, which is smelted in an electric high furnace, has a daily output of about 20 tons. It manufactures two types of iron. The one containing high carbon has 4 per cent. of that element, associated with 0.6 to 0.7 per cent. of vanadium, 0.3 to 0.5 per cent. titanium, and less than 0.025 per cent. sulphur and phosphorus. The silicon and manganese range between 0.2 and 3 per cent., according to the ultimate use. The second type of iron is compounded to resemble a cold-blast quality. It is made at a much lower temperature than the former one. The carbon can vary between 3 and 3.7 per cent.; vanadium from 0.4 to 0.7; the sulphur is not higher than 0.06; the phosphorus not more than 0.025 per cent.; the titanium ranges from 0.1 to 0.3; the silicon between 1.4 and 3.5 per cent., according to the castings to be made; whilst the manganese has a range of from 0.2 to 3 per cent.

The effect of vanadium, according to the author, is that up to 0.6 per cent. of vanadium the irons are grey with a pearlitic and troosto-sorbite structure. Between 0.6 and 0.8 per cent. mottled iron is produced having complex carbides, whilst above this figure it produces white irons having no free graphite. Actually, below 0.6 per cent., the combined carbon has already exceeded the pearlitic content, and if the vanadium is badly distributed throughout the mass, it is possible to see carbides. The hardening is important, even in the zones where the irons are still grey, due to the dissolution of a part of the vanadium in the ferrite and the formation of granular pearlite, which very probably contains a high percentage of V_4C_3. An iron of pearlitic structure containing T.C. 3 per cent., Si 1.5, Mn 0.5 and S 0.01 per cent. undergoes no material change when it has an addition up to 0.45 per cent. of vanadium, if cast into dried-sand moulds for making test-pieces of 25 millimetres dia., but above 0.5 per cent. of vanadium free carbides appear.

The best use of vanadium can be made for increasing the strength of the metallic matrix of low-carbon cast iron, so as to reduce to a minimum the harmful action of the graphite, whilst retaining good moulding properties and ease of machining. The modulus of elasticity is the surest criterion of the mechanical quality of foundry irons, and this modulus depends, to a large extent, on the quality and form of the free graphite. The efforts of metallurgists are being directed towards the obtaining of castings showing definite homogeneity and the most efficient method of obtaining this is to lower the total carbon and increase the silicon, so as to bestow a beneficial influence on the rate of cooling. Experience has shown that these results are obtained by lowering the carbon below 2.7 per cent., whilst increasing the silicon to above 2 per cent. A composition showing 2.6 per cent. total carbon, 1.4 silicon and 0.25 per cent. manganese, is one which gives rise to the first traces of free carbides, with an addition of 0.4 per cent. vanadium. A comparison of the mechanical properties of these two irons shows that with 0.3 per cent. of vanadium the Brinell hardness is increased from 255 to 305. The transverse, as determined by the Frémont method, shows an increase of from 950 to 1,005. The Shear test is improved from 45 to 52 kilogrammes per sq. mm., whilst the compression shows improvement of a similar order.

Influence of Titanium

In his review of the action of titanium on the properties of cast iron, the author draws largely upon the researches of Piwowarsky. Titanium is favourable towards the precipitation of primary graphite. Its effect is at a maximum at a content of 0.1 per cent. and is little affected by large variations in silicon. Above 0.1 per cent. titanium does not appear to modify the combined carbon of irons which have become pearlitic. The graphitising effect of 0.1 per cent. of titanium is considerable, and has, in consequence, a sharp action on the hardness of an iron initially mottled and containing 2 per cent. of graphite. From 0.3 per cent. titanium, an important increase in all the mechanical properties is noted, when the basis iron becomes completely grey with an addition of 2.75 per cent. of silicon. The improvement of the mechanical properties clearly take place starting from 0.1 per cent. of titanium. The transverse strength can, with 0.35 per cent. of titanium, be improved about 60 per cent.

In the later portions of his Paper the author points out that vanadium is to be esteemed, not on account of its deoxidising properties, as certain people imagine, but for its inherent alloying potentialities. He stresses both the thermal stability of pearlitic irons containing vanadium and their anti-growth properties. He recommends the use of vanadium for the manufacture of ingot moulds, stating that cast iron containing a stabilising element, in the pearlite, generally gives steelworks' ingot moulds a long life.

A Belgian foundry has recently reported that a mixture containing 50 per cent. of ingot-mould scrap, 35 per cent. ordinary hematite pig-iron and 15 per cent. of vanadium-titanium pig-iron (carbon 4.0 per cent., silicon 2.5 per cent.), which gave 0.1 per cent. of vanadium in the final composition, resulted in an increase in the life of the ingot moulds from 25 to 70 per cent., according to the type of mould and the manner of their use in the steelworks. Wear tests, carried out on internal-combustion engines, have shown that it is advantageous to use vanadium, and the main lines in France are now employing vanadium irons for their locomotive cylinders and piston segments. Its use, by retarding wear on the castings, has reduced the period between returns to the sheds for overhauling very considerably. The use of pearlitic irons, carrying vanadium and titanium of the following composition: T.C., 3.36 per cent.; C.C., 0.64; Si, 1.27; Mn, 0.47; S, 0.07; P, 0.20; Ti, 0.22 and V, 0.36 per cent., has been especially successful with piston segments, in spite of the fact that they are superheated to about 425 to 450 deg.

An Attempt to Standardise the Life Test

By Marcel Remy
(Delegate Director, Usines & Fonderies, M. Remy, Herstal.)

The determination of "life" will be standardised when in all countries and in all iron foundries

Life Index 10

indicates the same measure of this property within a known degree of precision.

The Accuracy of the determination of life in the foundry can admit of a tolerance of 5 per cent. (1 per cent. in the laboratory).

Test-Piece Shape

All countries are in agreement concerning the use of the spiral test-piece. The cross-sectional area of the spiral is that of a wire 6 mm. in dia. (28 sq. mm.), the actual shape being left a matter of choice.

The runner height of 100 mm. is convenient and in current use. The distance of 50 mm. between pips on the spiral appears to be satisfactory. There remains the factor of rate of delivery of metal into the mould, controlled by the section of the spiral or by the calibrated core.

Regulation of the rate of feed by the calibrated core is more accurate, easier to maintain constant and to control; but by the section of the spiral is simpler, and appears to be sufficient in practice.

Regulation of the speed of feed of the metal to the spiral can be attained by means of a filter or core, placed above or below the runner gate, provided that standard conditions can be maintained in practice.

The same remarks apply as to whether the runner gate should be placed at the centre or edge of the box, and as to the capacity of the receiving bob at the foot of the runner.

The test-piece should be moulded in green sand without venting at the end of the spiral. The mould should be placed level, and the pouring rate rapid (2 sec.).

The index of "life" is measured by the number of pips (placed 50 mm. apart) which can be counted on the spiral produced by the metal cast into the mould.

The measure is sufficiently accurate if read to half a division.

Mr. J. L. Wilson Goode, H.M. Trade Commissioner at Vancouver, is at present in this country on an official visit. Mr. Wilson Goode will be available at the Department of Overseas Trade on October 1 and 21 for the purpose of interviewing manufacturers and merchants interested in the export of United Kingdom goods to Western Canada. Between these dates he will visit a number of industrial centres in the provinces.

The Hand Ramming of Sand

By FR. BOUSSARD

[ABRIDGED ABSTRACT.]

The author defines the object of ramming sand as its transformation from a loose mass into a resistive mould. This mould must satisfy a certain number of foundry conditions. Before undertaking an examination of the latter, and in order to study the influence that ramming can have on them, it is necessary to establish methods by which they can be measured and the ramming of the sand characterised. A description is given of the Ronceray machine which is fairly clear from an examination of Fig. 1.

In order that the results may be properly comparable, the author took the weight of

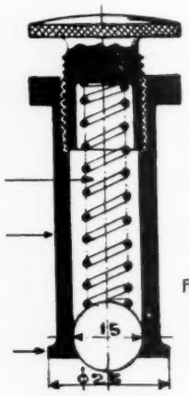


FIG. 1.

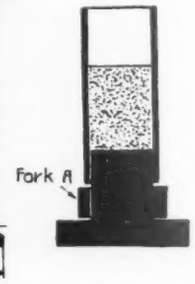


FIG. 2.

various sands so that, after ramming, the testpieces would have the same dimensions whilst being of different particles. The volume of the sand rammed in the testpiece being relatively small, it is important to determine if the ramming obtained by this method is regular and if the influence of the walls does not make itself felt to such an extent as to give a weak diameter of the testpiece. The testpiece is rammed in a tube of 50 millimetres diameter. Before ramming, this tube rests on a fork (A) as is shown in Fig. 2. At the moment ramming is started, the fork is lifted and the tube, deprived of support, is merely held owing to the friction of the sand. When the blows from the rammer are given, it descends progressively with this sand and the friction of the latter on the walls is almost non-existent. To confirm this, the author first rammed testpieces in a tube without the fork attached to the base. The measure of the hardness in the upper part and the lower gave the data necessary to trace the diagram shown in Fig. 3. An examination of this diagram shows that the hardness is greater at the top than at the bottom. Following this, the author carried out the same tests with the interposition and removal of the fork during ramming. No difference of hardness has been found between the top and the bottom of the testpieces. The results of these determinations, shown on the diagram, have been shown as a full line. It should be noted that this line represents a ramming slightly superior to the average of the two obtained in the first series of tests. The ramming obtained under these conditions can therefore be considered as regular and can serve as a basis for the comparison of different methods of ramming. These tests, made with a good green moulding sand, gave the result shown in Table I.

Fig. 4 shows the variation of the imprinting as a function of the number of blows of the rammer, *i.e.*, a function of the work expended for the ramming. This diagram allows one to place approximately the ramming of the sand. The measure made on the mould itself can be repeated any number of times, so as to control the regularity of the final ramming. By means of the ball-hardness test, it is possible to postulate that a sand is rammed, say, 30 per cent. This would mean that its volume has been decreased by 30 per cent. by ramming. This presents a particular interest for the moulder, or apprentice, and allows them to determine the capacity of the sand filler frame to obtain a definite degree of ramming. To postulate the law which regulates the reduction of volume, the author has worked, as set out above, on testpieces of 50 millimetres diameter but starting off with a definite weight of sand, *i.e.*, 150 grammes. The volume of the

TABLE I.—*Relation between Rammer Blows and Mould Hardness.*

Number of blows of the rammer ..	1	3	5	7	10	13
Weight of sand ..	135 grs.	150	160	164.5	170	174
Dia. of the imprint	11.3 mm.	8.4	7.5	7	6.3	6

testpiece has been measured after each rammer blow. The results have been set out on Fig. 5, which represents the variation per cent. of the volume, as a function of the numbers of rammer blows.

Ramming has been carried very far with the object of obtaining a complete curve comparable with the heaviest ramming encountered in practice. The diagram shows that for the first few blows the variation of the volume is considerable and allows an appreciation of the intensity of ramming to be had with some degree of exactitude. Unfortunately, it is not quite the same for the following blows. From the fourth or fifth blow, the reduction in volume, per blow, weakens; because of this the measurements become somewhat indefinite.

The principal factor to take into consideration, when determining the hardness to aim for in foundry moulds, is obviously the pressure exerted upon the sand by the liquid metal. A mould of considerable height will always be

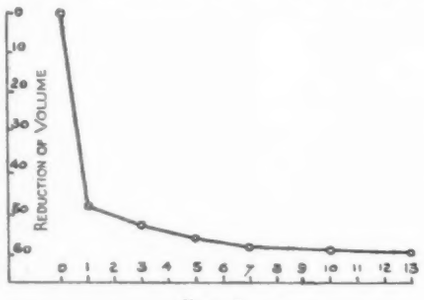


FIG. 5.

rammed more in the lower portion, because, during casting, the iron in this position will exert a much greater pressure than upon the upper part. In order for iron to deform a mould, it is necessary that the pressure that it exerts on it be greater than that communicated during the last ramming. The author undertook a series of tests, using a rammer weighing 5 kg., falling from a height of 54 mm. This standardised the amount of work done, and he has correlated this work with the reduction in length of the test-piece.

He next worked out the pressure exerted by a column of liquid iron at various heights ranging from 5 centimetres to 5 kilometres. Naturally, the figures derived from the work done relate to a static effect; but, naturally, when filling a mould there is a dynamic effect also, and it is necessary in practice to double them.

Work Done by Ramming

The figures taken in a number of French foundries indicate that moulds, rammed by hand, show pressures varying from 200 gr. to 8 kg. per sq. cm. Others taken in Germany have given figures ranging between 726 gr. to 2.7 kg. Naturally, the permeability varies with the thicknesses of the sand wall. This aspect of the question has been studied, using 50-mm. diameter test-pieces of 53 mm. in length, which were

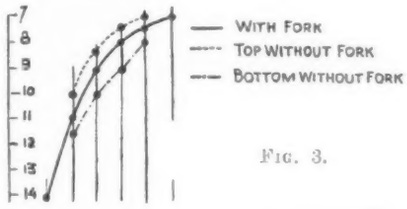


FIG. 3.

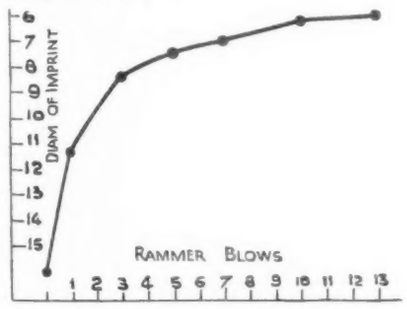


FIG. 4.

rammed under similar conditions. Then the permeability of one test-piece has been taken, then two, three and four placed in series. The results obtained are given in Table II.

It is thus obvious that the permeability varies in inverse ratio to the depth of the sand.

Dealing with the influence of moisture on the permeability of sand, the author states that there exists a definite content of water at which permeability is at a maximum. The same thing is true for the cohesion curve. The sand used in practice has often the moisture content corresponding to the maxima of these curves.

In order to simplify the problem of the influence of the depth of ramming, the total

TABLE II.—*Sand Section and Permeability.*

Thickness of sand.	Time for the passage of one litre of air under pressure.
53 mm.	56 sec.
106 ,,	108 ,,
159 ,,	162 ,,
212 ,,	213 ,,

quantity of the sand necessary to reach the wished-for depth was placed in a box and given one single blow. The author successively studied ramming depths of 80, 120, 200 and 400 mm. The last depth, it is thought, exceeds what is encountered in practice.

Fig. 6 shows, for these various rammings, the variation of the depth of the sand in the box, as a function of the work done by square decimetre. To determine this work, the author has evaluated the blows of the flat rammer necessary to reduce all the surface of the sand to different depths. The flat rammer fell, each time, from the same height. It worked alone

for the major depths of ramming. The sand of the lower half only received a small amount of ramming. From this fact, the hardness is irregular.

Best Depth of Ram to Use

Fig. 7 has been established for different depths of ramming. It shows the decrease in volume per cent. as a function of the work done by cubic decimetre of sand. The best ramming appears to be done when the depth of ramming

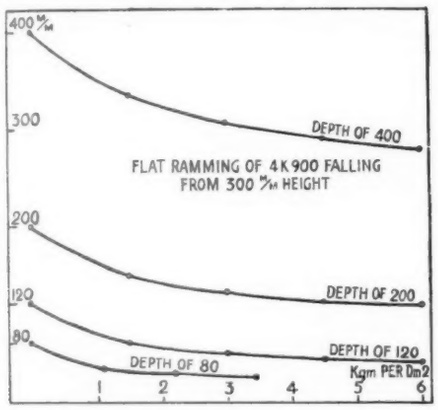


FIG. 6.

is in the neighbourhood of 120 mm. The friction of the grains of sand of the upper part, against the walls of the box is high and stops the lower portion from being rammed. With these rammings it is scarcely necessary to exceed a ramming of 35 per cent. Production is increased when the depth of the sand decreases. All the same, there is a limit to this improvement, because ramming at 80 is worse than that of 120. This is due to the utilisation of very strong blows of the flat rammer. When using small rammings, the sand rams itself relatively quickly. A part of the ramming effort is transmitted to the base supporting the box. Thus a certain quantity of the work done is pure loss. This apparent anomaly, obviously, introduces the question of the importance of the blows of the flat rammer.

Shape of Rammers

The author has devoted some space to a study of the shape of rammers; he recalls that all types and weights of rammers are encountered in various foundries and he chose four types amongst those which are normally utilised.

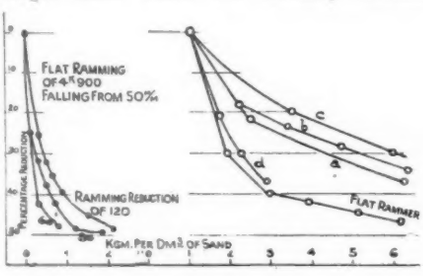


FIG. 7. FIG. 8.

These rammers respectively weighed 2½, 2, 1.85 and 1.6 kg. They were all quite different shapes, though each had been used for the ramming of identical moulds.

Fig. 8 shows the work done per cubic decimetre of sand, as a function of the ramming per cent. obtained for each one of these rammers, side by side with a flat rammer of 4.9 kg. It is obvious that rammers, taken at hazard, give very variable output. It is not possible to postulate a rule from this test, because the rammers have shapes too ill-defined. In order to study the shape of rammers, the author has decided to adopt a rammer of the type having properly determined dimensions and approaching, as near as possible, to the rammers normally used in the foundry. Rammers have been decided upon with the same dimensions, with the exception of the width of the base, which is respectively 30, 20, 10 and 0 mm. and carrying a variation in the inclination of the sides.

Fig. 9 shows these four rammers. In order to study the influence of the shape of the rammer, the question of its weight has been eliminated and it has been standardised at 1.6 kg. in the four cases.

It should be noted that as a general rule the rammers used in foundries are often very worn and they can be classed as C or even between C and D (Fig. 9).

Fig. 10 shows the work done in ramming moulds to various intensities when using successively the four rammers and flat rammer. It is immediately shown that rammer D has given the worst output in terms of work done because it only allows the attaining of weak percentage rammings. Table III shows the comparison for a definite ramming:—

TABLE III.—*Work Done in kgm. per dm.³*

Percentage reduction.	Type of rammer.			
	A.	B.	C.	D.
20 per cent.	1	1.6	3.4	4.4
30 ,,	2	3.4	6.2	Impossible
40 ,,	3.6	6	10.5	,,

The Case for the Flat Rammers

It is thus clear that the rammer with the rectangular section and flat surface gives the best output. In practice, however, rammers often have trapezoidal section. The explanation given in order to justify this shape is that the rammer should be tapered in order to ease its leaving the sand, or again that it can produce a lateral ramming. It should be pointed out that if one puts a taper on a rammer there will finally be a greater expenditure of work. This is explainable by the fact that the lateral ramming produces increased friction by the rammer on the sand and moreover that each rammer blow destroys a portion of the ramming obtained by the proceeding blows. It is thus suggested that rectangular rammers having no taper should be used. In examining moulds after each ramming it is noticed that with a flat rammer the sand is rammed up to the upper surface, and loose sand can no longer be distinguished, the upper surface being very regular. On the other hand, when a strongly tapered hammer is being used, a layer of from 4 to 5 cm. of loose sand is found. If this loose sand is caused to fall by turning over the box, there then appears a surface of rammed sand where can be seen the imprint of each rammer blow. The bottom of these imprints is very hard, but the portions situated between them are much less rammed. Here then there is an upper surface showing a large number of depressions (base of the imprint) and of hillocks (the parts situated between the imprints).

From this examination the conclusion is drawn that the permeability of a mould rammed under the conditions outlined by means of a tapered rammer is certainly not as good as that rammed with a flat rammer. In practice, however, there is the usual objection that the upper surface of sand rammed with a flat rammer is smooth and because of this, less permeable to gas. This is untrue. The surface carrying small hillocks, however, is interesting for the adding of successive rammings from the point of view of the adherence of one ramming to another. These hillocks stop the layers of sand directly superimposed upon them from slipping upon each other. This can happen in the case where the sand in the mould is bent. However, in order to ascertain the manner in which layers of sand attach themselves to one another, the author rammed in sand some cylinders of 300 mm. dia. and 500 mm. high, always using the different types of rammers. The cylinders were made stratified and by employing light blows with the hand they could be separated into successive layers. In every case each ramming was clearly shown and on the joint of each one of them a trace of the rammer blows could be seen. Separation was obtained a little easier where the flat rammer had been used. In each case the superiority of one rammer over the others from the point of view of adherence between the rammings is relatively small. The rectangular-shaped rammer having the best output has been taken as the basis in order to simplify the problem. To ascertain the output of a trapezoidal

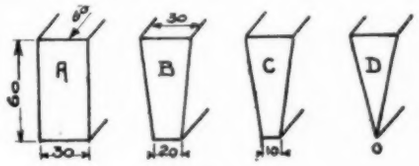


FIG. 9.

rammer, it will suffice to fix a base from a coefficient easily calculated with the help of the data of Table III.

How to Make Blows with a Rammer

Rammer blows can be applied in three different ways:—(1) Allow the rammer to fall freely; (2) throw the rammer by freeing it from the hand after having given it a certain amount of momentum, and (3) hit the sand whilst holding the rammer.

The blow is more powerful if the rammer is not freed, but because of its tiring effect on the workman this method is not recommended. If a momentum is given to the rammer immediately before loosing it, the output increases from 40 to 100 per cent. in comparison with that of a rammer falling freely from the same height and the resulting fatigue is scarcely greater. This increase of output obviously varies according to the weight of the rammer and the height from which it falls. With a rammer of 2 kg. (4 lbs. 6 ozs.) thrown from a height of 15 cm. (6 in.), the intensity of the blow is doubled. With a flat rammer of 5 kg. (11 lbs.) falling 30 cm. (1 ft.), the increase is not more than 50 per cent.

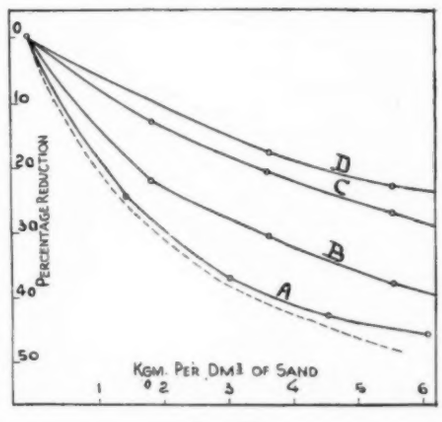


FIG. 10.

The Human Element

Up to the present the author has examined the various factors acting upon the ramming of sand with the object of reducing the expenditure of work to a minimum. This only incompletely solves the problem, because in practice it is also necessary to ram as quickly as possible. Herein enters the human element. To examine this latter, the author made a series of experiments, with the co-operation of a number of

high-grade moulders, who used in turn rammers of increasing weight, all lifted to a height of 15 cm. (6 in.). The average results obtained are set out in Table IV. Independent of the question of fatigue, it would appear that the heavier the hammer the more work per minute a man can do.

TABLE IV.—*Effect of Human Element on Ramming.*

Ramming.	Weight of rammer in kg.	No. of possible blows per min.	Work done kgm. per min.	Remarks.
With 1 hand ..	0.15	180	4.5	
,, ,, ..	0.74	140	15.4	
,, ,, ..	1.14	130	22.3	
,, ,, ..	1.60	110	26.4	
,, ,, ..	3.50	82	43	fatiguing after few minutes.
,, ,, ..	4.90	72	53	fatiguing from the start.
With 2 hands ..	9.10	60	82	
,, ,, ..	16.20	44	107	

Conclusions

The most important factor entering into the problem of ramming is the weight of the rammer, for upon this depends the good output of the workmen. For the ramming of large volumes of sand or for filling in, flat rammers, weighing from 4 to 5 kg. (8½ to 11 lbs.), should be chosen. In certain cases rammers weighing up to 10 kg. (22 lbs.) can be utilised, using, of course, two hands. For ramming up boxes, rammers which generally do not weigh more than 1½ to 2½ kg. can without inconvenience weigh up to 3½ kg. (7½ lbs.). It has also been shown that it is desirable to give the smallest blow possible per unit of surface of the sand in order to obtain the best output per rammer blow. In order to satisfy the second point, in spite of the increase in weight of the rammer, it is necessary to increase the surface area of the base. Thus the intensity of the blow per sq. decimetre will be reduced. All this obviously is conditional upon one not being limited in the choice of the section of the rammer nor by the distance between the patterns and the boxes, nor by other difficulties to be associated with the art of moulding. If restricted places demand a smaller rammer, the output factors and speed of ramming will no longer be in line with each other. For example, from two diagrams (not reproduced) it is clearly shown that for ramming reduction of 80 to 120 mm., the intensities are 0.49 kg.m. per blow. As the flat rammer, which has been suggested, has a section of half a sq. dm., the blow necessary per sq. dm. of rammer is 1 kg.m. With a rammer of 2½ kg., and in order to have a good production, it is necessary, if it is worked from a height of 14 cm., and if account be taken of an increased efficiency of 45 per cent. to adopt a section of 50 sq. cm. Thereby there would be available from each blow a work output of 0.5 kg.m. A flat rammer of 5 kg.m., used under the same conditions, ought not to have a section less than 100 sq. cm. Each case should be separately considered, and it is impossible to outline a general rule. However, it is best to adopt small depths of ramming; rammers as heavy as possible up to 3 to 3½ kg.; the largest possible section rammers and, as far as possible, flat rammers of rectangular section. Moreover, moulds should be rammed as lightly as possible.

Finally, by utilising the precepts outlined, it is possible in some cases to reduce from 12 to 3 minutes the time necessary for the making of a mould.

LAUNCHES on the Tyne in the eight months of this year totalled 15 vessels of 60,220 tons gross, compared with 11 ships and 21,263 tons in the corresponding period last year, an increase of four vessels and 38,957 tons.

The Utilisation of Electric Arc Furnaces

By M. BOUTIGNY.

(*Abstract.*)

It has been established that in furnaces of given capacity, there exists a maximum tension in the arc on the one hand and on the other a maximum melting rate, and if these figures are exceeded there is likelihood of danger to the refractories, and also a bad effect on the quality of the metal made. Because of this, the author has devoted a considerable amount of space to dealing with the regulation of the arc both during melting and refining. Later in his Paper the author deals with the metallurgical reactions which take place when operating an electric furnace under both basic and acid conditions. The reducing slag, when operating under basic conditions, is usually composed of six parts of lime, one of silica and one of fluor spar, plus one of coke. At the end of the desulphurising operation, the composition of the slag is CaO 60; SiO_2 20; MgO 13.5, Al_2O_3; CaS 3, and FeO 0.5 per cent.

The author puts forward a number of precautions to take when using electric-furnace steel in the manufacture of castings.

1. To use a ladle having the stopper very hot.
2. To reduce to a minimum the distance between the furnace and the moulding floors.
3. To make the runners so that they can withstand the pressure of the metal without being damaged, because this pressure is considerably higher than when lip-pouring is practised.
4. To see that the ingates of the castings are bigger than when using converter steel, or cupola iron, so as to have the time for filling the mould considerably reduced.

These recommendations are made because electric-furnace steel is more highly killed than other steels, as the various reactions have been completely finished. It freezes more quickly than converter metal, and this fact renders possible the utilisation of similar feeding heads.

The last part of the Paper is devoted to duplexing. Under these conditions the electric furnace can have its transformer capacity reduced between 58 and 60 per cent. The author deals with four processes, combinations of the basic Bessemer, the rotating furnace, the cupola and the blast furnace with the electric furnace. The first and last, possessing little interest to the foundry, can be dismissed. The question of duplexing between the rotary furnace and the electric furnace is a matter of some importance. According to the author, the large rotary furnace as a plant for melting steel is both practical and economical. By this the author means those of capacities varying from five to fifteen tons. Two such furnaces of a capacity of four tons have been installed in Sweden at the Bofors Works, where they are operating in conjunction with an electric furnace. They provide steel for both ingots and the foundry, which was previously served by a Siemens furnace. A third and still larger furnace has just been put into service quite recently in France with success. At Bofors, the metal is rapidly melted, quickly deoxidised, and brought to temperature. It is teamed into a ladle, which takes it to the electric furnace, where complete refinement is carried out.

The rotary furnace shows a distinct advantage over the Siemens furnace on account of its low installation cost, and the elasticity of operation. A cold furnace can receive a six-ton charge after 45 min. of preheating and melt it in about three hours.

The great advantage of utilising an electric furnace in conjunction with a cupola is that it is easily possible to superheat the metal and this destroys any graphite nuclei which may exist in the metal, and whilst this is taking place, there is a considerable reduction in the sulphur content. Superheating brings into being a carbon eutectic, with which is to be associated metal of high fluidity; mechanical strength, and resistance to wear and heat. The electric furnace readily lends itself to the production under controlled conditions of pearlitic, austenitic, martensitic, and ferritic irons with high chrome content.

The Soda-Ash Process in the Foundry

By ACHILLE G. LEFEBVRE.

[EXTRACT.]

The author after a short introduction of a general character outlines the reactions which take place between the soda ash and the various chemical compounds existing in cast iron. Later he deals with the methods used for obtaining the best results and stresses the character of the lining of the ladle, stating that silico-aluminous linings are liable to enrich the slag with silica which is prejudicial to the main reaction. He suggests that the sole method available for preventing this contamination is by lining the ladles with a graphite cement or with magnesite. In ordinary practice, however, it is sufficient to neutralise the silico-aluminous patching material (12 to 20 per cent.) with an addition of 8 to 10 per cent. of plumbago or graphite powder. This refractory mixture should be rammed both hard and on the dry side. In his next section of the Paper the author deals with the addition of soda-ash briquettes to the cupola. His conclusions are summarised in the following statement:—(1) The formation of a very fluid and very active soda-lime slag; (2) better and quicker melting; (3) the reactivity of the coke being catalysed by the soda induces an economy in fuel consumption, and (4) improvement in the quality of the iron.

A further effect resulting from the addition of soda to the cupola has been reported by one foundry, and that is that it tends to reduce the total carbon in the iron. This conclusion, however, still requires confirmation. The author suggests that it seems more rational to carry out the soda-ash treatment at the blast-furnace plant. His final section deals with converter steel, and a table which is included shows that there is some measurable improvement in soda-ash treated steel as against material made in the ordinary way. He summarises the results in the following statement:—The physical qualities of steel obtained, that is, the tensile strength, elongation and resilience are improved considerably, due entirely to the sole fact of de-sulphurisation. In practice it is often observed that even with sulphur contents which are the same both before and after treatment, the mechanical properties of the steel are notably improved. This improvement shows up in a case where, because of some accidental happening, no reduction of sulphur is noted. The structural improvement of treated irons, which are shown as micrographs in the Paper, confirm this. Improved "life" is shown by the spiral test, in spite of the lower temperature resulting from the time necessary for the carrying out of the treatment. In addition, there is a lowered tendency to cracks and porosity.

THE OUTPUT of the Polish iron and steel works during July showed a marked increase compared with June. The figures for July (June) were:—Pig-iron, 32,999 (27,963) tons; steel, 86,329 (66,818) tons; rolled products, 62,737 (48,397) tons. The increase in the production of pipes and tubes was 68.4 per cent. Sales of rolled products in Poland also improved. The export of rolled products during July totalled 11,529 tons, about the same as in June. The export of tubes gained 1,538 tons at 3,407 tons.

Metallic Losses in Cupola Melting

By GUY HÉNON

Most foundries deal with the determination of metallic losses on strict accountancy lines, *i.e.*, by ascertaining the difference between the weight of metal used and the weight of metal produced. In point of fact, the figure thus obtained includes not only the loss resulting from oxidation in the cupola, but also all metal carried away with the slag, as also shot, fins and miscellaneous scrap which is not weighed or utilised again, etc. Finally, this method of computation does not generally take into account the various extraneous substances, which are weighed with the charge, such as the sand still adhering to the pig, discards, etc. The loss determined in this manner may be useful for costing purposes, but the information thus afforded is not of great assistance to the technician. The latter can indeed determine the true metallic losses by carefully weighing all that goes into the charge, and then all that has been cast, including the whole of the waste. In the author's opinion, however, this method has two serious disadvantages:—(1) It entails heavy additional handling operations and (2) it cannot be accurate, inasmuch as relative errors can hardly be detected when dealing with quantities smaller than 1 per cent. or so, which is generally

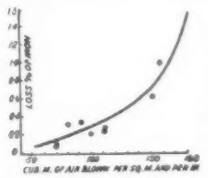


FIG. 1.

(Section of furnace measured at beginning of melting zone.)

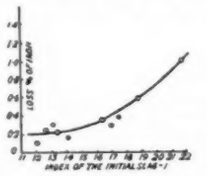


FIG. 2.

$I = \frac{\text{Oxygen in the Silica}}{\text{Oxygen in the Bases (not taking the ferric and manganous oxides into account.)}}$

the approximate percentage represented by metallic losses. On the other hand, the slightest omission in the list of castings is liable completely to falsify the result. Notwithstanding these serious objections, the author has not so far encountered any other practical method for the determination of metallic losses, either in actual foundry practice or in the technical Press.

Method Suggested

The method generally used by the author is based upon the following considerations:—

All the iron oxidised in the course of the melting operation is carried away with the slag. Accurate knowledge of the weight of the slag and of its iron content should therefore be sufficient to determine the quantity of oxidised iron, duly bearing in mind the quantity of iron brought into the slag by the limestone and the patching. It is, however, difficult to ascertain the weight of the slag by direct weighing, as there always remains a certain quantity of slag in the cupola, and, on the other hand, fragments of coke and metal, which are liable to falsify the weighings, are frequently carried away by the slag.

Yet, the weight of the slag can be determined simply and accurately in relation to the weight of the limestone charged, the lime content of the limestone and the lime content of the slag. It is known, on the one hand, that all the lime contained in the slag comes from the limestone, apart from a negligible quantity originating from the coke ashes. On the other hand, all the lime contained in the limestone necessarily gets into the slag, with the exception of such small fragments of limestone as happen to be carried away into the shaft and the weight of which is generally negligible. Accurate weighing of the limestone and determination of the lime contained in the slag and in the limestone will, therefore, be sufficient to determine accurately the weight of the slag.

All the factors required for the calculation of metallic losses are accordingly available.

Example

The author has purposely selected a rather complicated case as an example, but the calculation is frequently much simpler in current practice.

Data:

Quantity of pig-iron charged in the course of the melting operation	61,200 kg.
Weight of the limestone charged	3,055 kg.
Weight of the patching used for repair	2,500 kg.
Iron content of the pig charged	92.3 per cent.
Lime content of the limestone (the limestone used being free from ferric oxide)	54.0 per cent.
Iron content of the patching (the patching containing only traces of lime)	2.05 per cent.
Lime content of the slag ...	34.08 per cent.
Iron content of the slag ...	3.25 per cent.
Lime content of the coke, approximately	0.5 per cent.

The above data being known, it is possible to proceed with the determination of metallic losses, as follows:—

Iron charged, 61,200 kg. × 92.3 per cent.	56,400 kg.
Net weight of the limestone (6 per cent. moisture deducted)	2,870 kg.
Weight of CaO charged in the form of limestone: 2,870 kg. × 54 per cent.	1,545 kg.
Weight of CaO introduced by the coke ashes: 6,200 kg. × 0.5 per cent.	31 kg.
Total CaO charged	1,576 kg.
CaO found in the slag	34.8 per cent.
Weight of the slag: $\frac{1,576 \times 100}{34.8}$	4,528 kg.
Weight of the iron contained in the slag: $\frac{4,528 \times 3.5}{100}$	147.16 kg.

From this quantity must be deducted the iron brought in by the patching, *i.e.*, 2,500 kg. × 2.05 per cent. = 51.25 kg. The loss per cent. is now calculated as follows:—

$$\frac{(147.16 - 51.25) \times 100}{61,200} = 0.156 \text{ per cent.}$$

In the case considered above, the true metallic losses are therefore equal to 0.156 per cent. of the iron charged.

This figure is consistent with the thoroughly satisfactory operation of the furnace.

Conditions for the Application of the Method

In order to obtain sufficiently accurate results, it is essential that the following requirements be fulfilled:—The limestone must be weighed accurately. The best method to ensure the necessary accuracy consists in weighing a greater quantity of limestone than required for melting and then ascertaining the weight of what is left when the operation is completed. In this way only two weighings are made, and there is no risk of adding together any small errors made at each charge. Moreover, the man responsible for charging is free to proceed in the manner to which he is accustomed—volumetric measurement, counting the shovels, etc.

The materials charged must be as free from rust as possible, in order that the quantity of melted rust introduced into the slag should not be such as to falsify the result. This danger can be obviated by a careful selection of the materials used for the melting operation in the course of which the test is to be carried out, all heavily-rusted parts being also cleaned off by sand-blasting if required.

Sampling of the slag must be effected correctly, appreciably equal quantities being drawn periodically. It is, of course, essential that the analysis of the slag should be truly representative of the mean composition obtaining during the melting operation.

Possible Simplifications

In most cases the patching used for repairing the cupola furnace contains no ferric oxide, and no deduction need therefore be made in this respect. The quantity of lime contained in the coke ashes is generally so small that it can be disregarded altogether. Finally, limestone obtained from an approved source of supply is usually of fairly consistent composition, so that the analysis need not be repeated for each test.

Consequently, the metallic losses can be determined by means of the following operations:—(1) Weighing the limestone by the differential method, (2) determination of the lime content of the slag, (3) determination of the iron content of the slag and (4) calculations. The whole procedure is, therefore, comparatively simple.

Influence of Various Factors on Metallic Losses

The diagrams appended hereto show how the metallic losses are capable of varying under the influence of various factors. The author's own tests have not been numerous enough nor have they been carried out in a sufficiently systematic manner to warrant these diagrams being looked upon as anything more than an approximate expression of the general character of the laws governing such variations. To plot these curves with accuracy it would have been necessary to vary, in each case, only the one factor whose influence was being considered. This could not be done, however, because each of the marks referred to a different furnace. The grouping of these marks is, nevertheless, sufficiently characteristic, in each case, to enable the approximate trend of the governing law to be deduced from the data available.

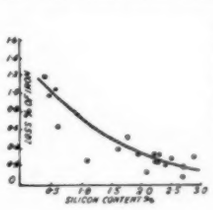


FIG. 3.

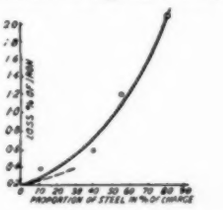


FIG. 4.

(Broken Line = Mean Loss for Cupola Furnaces Melting no Steel.)

Fig. 1 represents the variation of metallic losses under the influence of the volume of air blown into the furnace per unit of the melting-zone section. As might have been expected, oxidation increases simultaneously with the introduction of an increased volume of air. Fig. 2 shows the influence exerted by the slag index on metallic losses. The loss is generally greater in the case of the more acid slags. Fig. 3 illustrates the influence exerted on the metallic loss by the silicon content of the metal melted. The highest metallic losses are to be found in the pig-irons whose silicon content is the smallest. This result was to be expected, as it is a consequence of the law governing the action of the mass. The oxygen combines with the silicon, this being the most oxidable element, and also with the iron, which is the most abundant element. The oxidation of the iron is, therefore, necessarily more extensive when the silicon content is low.

Confirmation of the foregoing is afforded by Fig. 4, representing the influence exerted on the metallic loss by the proportion of steel scrap incorporated in the charges. It can be seen that the loss increases rapidly with the proportion of scrap, the latter being very low in silicon.

XUM

Artificial Core Bonding Materials

By A. SWAGGERMAN.

[EXTRACT.]

The author of this Paper has carried out a series of tests with the object of evaluating the worth of the various types of artificial core oils on the market. He used, as a basis for experiments, pure silica sand, practically free from clay and silt, which showed, on sieving, that 74.52 per cent. of the material remained on 70 mesh per sq. in. and 21.82 per cent. on 100 mesh per sq. in. It gave a degree of fineness of 47.09 and a regularity of 60.3 per cent. The author gives the following *résumé* of his researches:—

(*a*) The two most important factors to be taken into consideration when evaluating an artificial bonding material are:—(1) The liability to absorb moisture; and (2) the amount of gas which is evolved.

(*b*) In order to establish bases for the comparison between various core oils, a description of the different tests has been given, in order to explain:—(1) The determination of the loss in strength, so as to ascertain a basis for the measurement of the liability to pick up moisture; (2) tests of the gas pressure; (3) the determination of the loss of weight; and (4) the determination of the volumes of the gas.

Of the last three determinations, No. 3—which is the most efficient and simplest for providing a comparison between different types of oils, refers to the evolution of gas when heated.

(*c*) Finally, the conclusion was arrived at that it was impossible to draw up a specification showing the qualities to which a good bonding material should conform, because the exigencies encountered in each foundry varied so much.

Internal Tensions in Grey Iron

By J. NAVARRO-ALCACER.

[SPANISH EXCHANGE PAPER: EXTRACT.]

The present Paper following upon earlier researches into the numerical relations between the mechanical coefficients of grey iron, sets out to clarify some conceptions about the work of rupture by static bending and to state their significance. The difference which is established between the work done by the machine (which is that which is applied to the test-piece) and that which the material develops (which is that measured by the diagram) has made possible the establishment of the importance, in certain cases, of internal tensions, of which the values, seemingly augmented by the efforts of the breaking and the crushing of the graphite laminæ, bring about much internal slipping of the material in the direction of the deflections of the internal tensions. This causes an increase in factors which affect the machine and that which comes about when the graphite is coarse—a very considerable additional work.

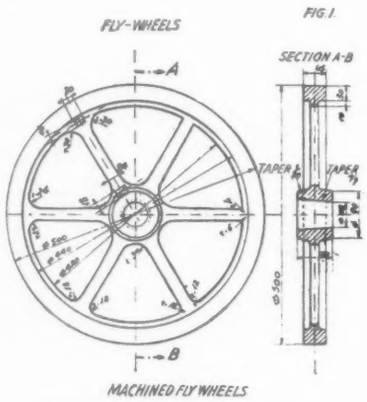
In irons having fine graphite—a material approaching somewhat towards steel—the difference between the work done by the machine and that developed by the test-piece (measured in the diagram) is practically nil. Its form—practically a straight line—is similar to steels within their period of elasticity. On the other hand, in ferrite-pearlite irons with coarse graphite, the slippings of the material—sensitive even under small loadings—give appreciable deflections, and the curvature of the diagram checks up from the starting of loading with the momentary coefficients of elasticity (tangents) which increase similarly to the diagrams corresponding to irons having finer graphite. It is as if an internal motor in the material was helping the machine in its work. This latter develops much less work than that which is measured on the diagram, which would be due to the influence of the work of internal tensions having been created in the material.

The Size of Fillets

By Prof. RENÉ PAQUET.

In order to study the effects of fillets, the author worked upon small flywheels, which were ruptured by centrifugal force. Some of these were "as cast" and some were machined from solid discs (Fig. 1). X-ray examinations were made to ascertain that no draws or spongy areas were present. His results are set out in Fig. 2. The composition of the iron was T.C. 2.67, Si 2.42 and P 1.37 per cent.

FIG 1

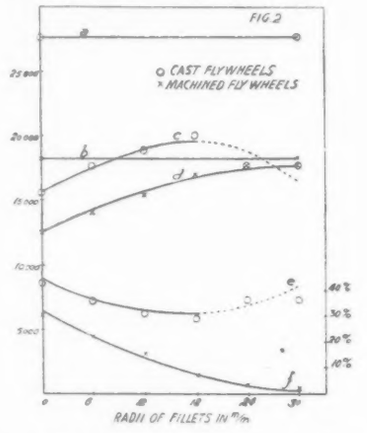


The spokeless rim shown is a theoretical conception to act as basis for the test results. The Professor draws the following conclusions:—

For the completely machined flywheels, which are virtually free from contraction stresses, the strength increases with increase of size of fillet; this increase is at first quite marked for fairly small fillets, but becomes insignificant when the fillet reaches certain proportions.

In the cast flywheels, there is equally an improvement of strength conditions with increase of size of fillets, but this improvement rapidly tends towards a maximum, after which increase in size of fillet is definitely deleterious.

FIG 2



The difference registered between the loss of relative strength in the two cases cited clearly indicates that the stresses due to contraction increase with the size of the fillet—a foregone conclusion. In general, the increase of size of fillet diminishes the suppleness of the spoke and rim. There is a maximum proportion to give to fillets, after which the effect is detrimental to strength.

MESSRS. RICHARD THOMAS & COMPANY, LIMITED, have restarted a blast furnace at their Redbourn Hill works, Scunthorpe, where there are now three furnaces working.

Cast-Iron Plate Roofing

An article in the latest issue of the "Iron Age" to reach this country deals with the interesting application of cast iron as a roofing material. It is pointed out that in reality the application is not new by any means, but dates back hundreds of years. The oldest existing cast-iron roofing seems to be that on the famous Chinese temple at Tai Shan. Three buildings forming this group, constructed about 500 years ago, as historical records indicate, are provided with cast-iron roofs, still in service and in excellent condition.

Another notable specimen of cast-iron roofing is that on the great dome of the Capitol Building at Washington, constructed of cast-iron roof plates, floor plates, columns and railings. The material was cast in 1861 and installed in 1870, about 65 years ago. In this period of time there has been no necessity for repairs in any of the cast iron elements, or any maintenance cost whatever. The well-known Cast Iron Building in California Street, San Francisco, was built in 1873 by the Hinckley Foundry Company of that city, of cast-iron units made at its plant. This structure was the only building to pass through the disastrous San Francisco fire of 1906 within its area, when all other structural materials suffered severely. The building is in regular use to-day. A distinctly industrial application of cast-iron roofing is found on the factory of H. B. Smith at Smithville, N.Y., erected in 1872. The cast-iron roofs are still intact and serviceable, and not a penny has been expended for maintenance or repairs since their installation 63 years ago.

As a recent departure in its business, the United States Pipe & Foundry Company, Burlington, N.J., manufacturers of cast-iron pressure pipe, have developed a cast-iron roofing material for industrial buildings. This iron unit and method of installation are of individual and distinctive character, with a broad range of flexibility for various types of plant structures. The cast-iron plates, as they may be termed, patented, are sold under the trade name of Usicast.

To make for lowest production costs, the iron plate unit with its few required accessories are standardised. The regular foundry equipment of

(*Concluded on page* 239.)

Churned Iron and Soda Treatment

(*Concluded from page* 223.)

contained a higher phosphorus content than the iron utilised in the experiment.

The following is a resumé made by the author:—

"Liquid cast iron spontaneously tends towards a state of chemico-physical equilibrium controlled by internal conditions, that is chemical compositions, and state of rest or of movement, and externally—that is temperature, and duration in the liquid state. Cast iron in chemico-physical equilibrium gives the best mechanical qualities. It is possible to accelerate the conversion to the state of equilibrium by mechanical means, which have been stated in the Paper and by chemical methods, which modify moreover the final equilibrium. The combination of the two methods is the best to follow. It is necessary to carry out the churning and the treatment in the same ladle filled in the ordinary way without either re-teaming or re-heating. This apparatus has been described as well as the *modus operandi* for using soda ash and ground limestone for the easy removal of the soda slag. It has been shown how to obtain the necessary equilibrium between the hardening and graphitising elements in order to procure a pearlitic structure in the iron.

Finally a table of figures, micrographs, and photographs of the modifications sustained in the iron by the treatment described have been included.

The Iron and Steel Institute

AUTUMN MEETING AT MANCHESTER

The Autumn Meeting of the Iron and Steel Institute, held last week at Manchester, was opened at 9.30 a.m. on Tuesday, September 17, at the College of Technology, by the Rt. Hon. the Earl of Crawford and Balcarres, P.C., K.T. (President of the Reception Committee), who occupied the chair at the commencement of the proceedings.

Lord Crawford said that this was the first occasion during the present century that the people of Lancashire had had the opportunity and the honour of welcoming the Iron and Steel Institute to their county. They did so with the utmost satisfaction. Not only were they closely concerned and intimately allied with all the great industries which the Institute represented, but the inhabitants of Lancashire, and particularly of the City of Manchester, were in the very centre of a great aggregation of population, of a wide and varied distribution of industry, of a very large and a very active market, and he might add—and he hoped that, after their experiences the following day, the members would agree with him—of a great spirit of enterprise.

He was glad to welcome the members of the Institute in order to dispel one of two great fallacies which seemed to envelop British opinion. On one he would not dwell; indeed, he would not name it; but the second fallacy was the fallacy that Lancashire was down and out. It would, he hoped, be possible to convince the members that in many ways the people of Lancashire were playing their full part in the development and the scrutiny of all those difficult problems which faced the enterprise and the prosperity of the country. They on their part were grateful for and would be heartened by the presence in their midst of so many who represented the great industries of iron and of steel.

He had the honour to invite their most distinguished guest and host, the Lord Mayor of Manchester, to welcome the Institute to the City.

CIVIC WELCOME

The Lord Mayor of Manchester (Alderman Samuel Woollam, J.P.), who was received with applause, said that it was a great privilege for him, as representing the citizens of Manchester, to offer to the Institute a very hearty welcome in the name of the citizens. Lord Crawford had very rightly drawn attention to the fact that a great many people who were not acquainted with Lancashire and Manchester had the idea that Lancashire was down and out. He could give the assurance that Lancashire, and Manchester in particular, was anything but down and out. One of the most encouraging things during his year of office had been the great improvement in Manchester and in Lancashire generally, of the engineering trades, which afforded some compensation for the loss of trade in the cotton industry. He believed that, as compared with a year ago, at least a thousand more people were employed by the engineering trades in Manchester. That was very encouraging, because as chief magistrate of the city he wished to see employment found for the people of Manchester, for employment created happy homes.

The College of Technology in which the Institute was meeting had done, and was doing, to-day a great deal to assist the engineering works of the city and the adjoining area, and he would be failing in his duty if he did not say how glad the civic authorities were to see present that day the Principal of the College (Mr. Mouat Jones), who had been ill for some time and whose illness had given all those associated with the College a very anxious time.

The members of the Institute could rest assured that Manchester would not only do its duty in seeing that they had a good time during their visit but was at all times ready to do its best to encourage the engineering trades, because by so doing employment was found for its citizens. In the name of the city he offered them a very hearty welcome, and hoped they would carry away with them very pleasant recollections of their visit.

Sir Harold Carpenter, Ph.D., F.R.S. (President of the Iron and Steel Institute), who responded, thanked Lord Crawford and the Lord Mayor of Manchester, on behalf of the members of the Institute and their ladies, for the delightful welcome they had given them. Lord Crawford, he said, had referred to the fact that this was the first visit which the Institute had paid to Manchester during the present century. That was true, but he would like to point out

Sir H. C. H. Carpenter, Ph.D., F.R.S.
(*President of the Iron and Steel Institute*).

that in the early days of the life of the Institute, at a time when it needed friends, there was no city which showed itself more friendly and generous than Manchester. The Institute was founded in 1869, and Manchester, although, as had been said, not pre-eminently a centre of metallurgy, showed its enterprise in recognising the work that such an Institute could do for its interests, with the result that the Institute met three times in Mancheser during the last century. There was no other city in the country which had that record.

The first meeting was in 1875, when the Institute was six years old and its membership numbered only a few hundreds. The President just previous to that meeting was the famous Sir Lowthian Bell, but the President at that first meeting in Manchester was Mr. William Menelaus. On looking through the "Journal" which gave an account of that meeting, he had been interested to notice the famous names of Bessemer, Crawshay, and that famous citizen of Manchester, Sir Joseph Whitworth. The second visit was in 1887, the year of the Jubilee Exhibition, and on that occasion the President was a Manchester citizen, Daniel Adamson—a name well known and honoured in Manchester to-day. There was a very remarkable exhibit at that meeting by the firm of Sir Joseph Whitworth & Company of hollow and solid ingots of cast steel made under their system of fluid compression, and hollow shafts, cubes and rings made under their system of hydraulic forging machines. One of the contributors to the discussion on that occasion was a Mr. F. W. Harbord, who was now one of the Past-Presidents of the Institute. He had hoped that Mr. Harbord would be present that morning; he was to be congratulated in that although it was now 48 years since he first contributed to a discussion before the Institute, he was still in the full tide of his mental powers.

The third visit was in 1899, and the President on that occasion was the late Sir William Roberts-Austen, a name of special interest to him personally, because Sir William was his predecessor at Manchester University and at the Royal School of Mines. Papers were presented at that meeting which had had a most profound effect on the engineering industry. It was the beginning of the period of metallography. One of the most important Papers at that time was by Dr. Stansfield, on "The Present Position of the Solution Theory of Carburised Iron."

The present was therefore the fourth visit of the Institute to Manchester. It was of interest to mention that more steel had been produced since the last visit of the Institute to Manchester than in the whole of the previous history of the world. That might sound a very remarkable statement, but it was quite true. The development of steel metallurgy had been very remarkable, but he wanted to stress not the quantitative side of production but the quality of the products, and he would like to give two or three examples showing how the advance in the industry which the Institute strove to serve had helped the industries in the Manchester district.

He would begin with cutting tools. When the Institute last met in Manchester, high-speed steels did not exist. The whole of the revolution created by the discovery of the rapid-cutting steels had taken place since that period. He would like to mention one of the early Papers on that subject, a Paper contributed by a citizen of Manchester, Mr. Leadhill. There were some present in the room that day who would remember that Paper, which was a very important one. Then there were the high-tensile steels which were used to-day in structural work. The most remarkable example of their use was the Sydney Harbour bridge, where 38,000 tons of steel were formed into a single arch. That would have been quite impossible 35 years ago. The heat-resisting and scale-resisting steels, which were so much used in plant to-day and which enabled high temperatures and pressures to be reached, had also been developed during this period; but probably the greatest discovery had been that of what was called stainless steel. The discovery of stainless steel was one of the major inventions of the century, and it could be said that the problem of the corrosion of steel was now solved. He meant, of course, the technical problem. Steel which would not corrode could be produced for a very large number of purposes, but whether people would pay to use it under such conditions was a commercial matter. Scientifically, however, the problem of corrosion had been solved, and to-day we were in the full tide of development of alloy-steel metallurgy. The previous services of the Institute to industry had been great, but he thought that to-day they were greater than they had ever been.

Presentation to Mr. G. C. Lloyd

Sir Harold Carpenter said the members would recall that two years ago Mr. G. C. Lloyd retired from the secretaryship of the Institute, after having been Assistant Secretary from 1900 to 1904 and Secretary from 1909 to 1933. At the time of his retirement the Council made a presentation to him, but since then a movement had been initiated among the members them-

selves, who were desirous of not letting Mr. Lloyd go without taking their share in a presentation also. That movement had the fullest support of the Council. Professor Andrew had been very active in the matter, and in a moment he would ask him to make the presentation. He wished to mention that the French members were not invited to subscribe because they had already made a presentation, and the German members had written conveying their best wishes to Mr. Lloyd. Finally, he would like to add that the subscription list was still open, and those who wished to contribute were asked to send their contributions to the Secretary.

PROF. J. H. ANDREW, in making the presentation, said he was sure that every member of the Institute would like to associate himself with the kind remarks which Sir Harold Carpenter had made with reference to Mr. Lloyd. They all recognised that the splendid position which the Institute had attained among the metallurgical societies of the world was due in no small measure to the efficient guidance which it had had at the hands of Mr. Lloyd, and they had always regarded him not only as their Secretary but as their counsellor and friend. His charming personality, his tact, and his modesty, emanating from a spirit of kindliness, had endeared him to them all.

They were presenting Mr. Lloyd that day with a desk and a cheque. Unfortunately a desk was rather a large article of furniture to hand over on such an occasion, and he would therefore hand to Mr. Lloyd an inscribed plate which would be firmly fixed on the desk, on which the inscription read:—

> "To George Christopher Lloyd, Secretary of the Iron and Steel Institute, 1909-1933, as a token of their affection and esteem, from his friends and members."

He ventured to suggest that no words were more sincerely engraved at any time.

Addressing Mr. Lloyd, Prof. Andrew continued: "We ask you on behalf of the members of the Iron and Steel Institute to accept this as a token of their affection, and we sincerely trust that you and Mrs. Lloyd will enjoy long life and happiness. In other words, may you enjoy all the good things that you have so honourably and truly earned."

The presentation was then made amid prolonged applause.

MR. G. C. LLOYD, in reply, said it was very difficult for him to find words in which to express his gratitude for the very kind manifestation of their goodwill which the members had shown him. He would like to thank them each personally, but they would find that a tiring business. He had actually been associated with the Institute for 29 years; he was Assistant Secretary for 4 years and then, after a short interval, returned to the Institute to take up the office of Secretary, which he held for 25 years. That might not seem a very long time, but he started rather late in life. It was his own suggestion that the time had come when it was desirable to retire, for he had become sadly conscious of what metallurgists called the ageing effect. It was not anybody's fault, but simply due to the efflux of time; he felt that the time had come—as it must come to everyone—to bid farewell to what had been the chief interest of his life and to make room for someone more capable of bearing the increased responsibilities which were growing year by year in connection with the Institute.

It had always been his aim to make himself as accessible as possible to the members, and it had been a very great privilege to find that he had gained a great multitude of friends in the course of his years of service. The great majority of his friends, of course, were among the British members, but he had also to express his gratitude to his French friends, who a little while ago, in the charming and unobtrusive manner which was theirs, prepared a felicitous gathering in London, presided over by Professor Portevin, and presented to him on that occasion a precious token of their friendship and esteem. That was done privately, but he wished now to take the opportunity of thanking them publicly for it. There were also members in many other countries among whom he counted numerous friends. He would like to call to mind the German members, with whom he had always been on the very best of terms, and from whom he had received many manifestations of kindness.

He would like to thank all those concerned. The Iron and Steel Institute was a sort of League of Nations, and he wished to thank every one of its members for their kindness to him.

He felt he must add a few words on the subject of the staff. No man was ever better served by a more loyal and devoted staff, both men and women, than he had been. He need mention no names; they were still with the Institute, and he thought the members knew them all personally. Finally, there was one other person to whom he owed the greatest debt of gratitude, and that was his wife, who was beside him in the meeting now. She wished to join with him in thanking the members for the very great kindness which they had shown him that day. Without her loving care and strict supervision he doubted whether it would have been possible for him to be there at all.

The Lord Mayor of Manchester then left the meeting, and Lord Crawford vacated the chair, which was taken by Sir Harold Carpenter, Ph.D., F.R.S. (President of the Institute).

Formal Business

The SECRETARY announced that the following would retire by rotation at the next annual meeting:—Vice-Presidents: Messrs. Alfred Hutchinson, John Craig, C.B.E., and H. Spence Thomas. Members of Council: Rt. Hon. the Earl of Dudley, M.C., Captain Robert S. Hilton, Messrs. I. F. L. Elliott, E. F. Law and Dr. T. Swinden.

The PRESIDENT announced that the date of the Annual Meeting in London had been provisionally fixed for May 7 and 8, 1936, the dinner being on the first evening. He had also to announce that an invitation had been received and accepted for the Autumn Meeting next year to be held in Düsseldorf. It would be 34 years since the Institute last met in Germany, and then it was at the same town. The meeting would probably be held during the week beginning Monday, September 21.

The scrutineers of the ballot reported that all the candidates proposed had been duly elected, and, on the motion of the President, the thanks of the Institute were accorded to them for their services.

Reading and discussion of Papers then proceeded.

After the morning session, members and their ladies were entertained at luncheon at the Midland Hotel by the Reception Committee. Afterwards visits were paid by the members to a number of works including Metropolitan-Vickers Electrical Company, Limited, Mather & Platt, Limited, Taylor Bros. & Company, Limited, Renold & Coventry Chain Company, Limited, and Rylands Bros., Limited. The undermentioned companies also expressed their willingness to receive members of the Institute during the afternoons of Tuesday and Wednesday:—Churchill Machine Tool Company, Limited, Craven Bros. (M/C), Limited, Ferranti, Limited, National Gas & Oil Engine Company, Limited, Geo. Richards & Company, Limited, Henry Simon, Limited. In the evening a civic reception to the members and ladies was given by the Lord Mayor and Corporation of the City of Manchester at the Town Hall.

On Wednesday members embarked at Salford Docks, on vessels provided by the Manchester Ship Canal Company, for a visit to the Irlam Works of the Lancashire Steel Corporation, Limited. Lunch was taken at Irlam by kind invitation of the Lancashire Steel Corporation, Limited, and afterwards visits were made to the coke ovens, blast furnaces, steel plant, and rolling mills.

In the evening, members and their ladies were entertained at a banquet, followed by a dance, at the Midland Hotel, by invitation of the Reception Committee.

On Thursday, by kind permission of the United Steel Companies, Limited, and the Millom & Askam Hematite Iron Company, Limited, the members visited the works at Moss Bay and at Millom. Lunch was taken at the Keswick Hotel, Keswick, by invitation of the United Steel Companies, Limited, and the Millom & Askam Hematite Iron Company, Limited. After lunch, the party divided, those visiting works travelling by motor coach from Keswick past Bassenthwaite Lake to the Moss Bay Works, Workington, of the United Steel Companies, Limited, and then by the coast road to the works at Millom of the Millom & Askam Hematite Iron Company, Limited. For ladies, and those members who did not wish to visit the works, a tour through other parts of the Lake District by motor coach and lake steamer was arranged.

Reception Committee's Luncheon

The luncheon for members of the Institute and their ladies, by invitation of the Reception Committee, held at the Midland Hotel, Manchester, on Tuesday, September 17, was presided over by the Rt. Hon. The Earl of Crawford and Balcarres, P.C., K.T. (President of the Reception Committee). About 420 members and guests were present, including Sir Harold Carpenter (President of the Institute) and Lady Carpenter, Mr. J. E. James (Chairman of the Reception Committee) and Mrs. James, Lord Balniel, Sir William J. Larke, K.B.E., Sir W. Peter Rylands, Sir Ernest Simon, Sir Felix Pole, Mr. W. R. Lysaght, C.B.E., Professor H. Louis, M.A., D.Sc., and Mr. B. Mouat Jones (Principal of the Manchester College of Technology).

The Loyal Toast having been duly honoured, the CHAIRMAN said that he was going to give them only one toast, but one which he was sure they would accept with acclamation. It was a toast expressing their thanks to the Principal and to the Trustees of the College of Technology for their kind hospitality to the Institute. He wished to associate it with the name of Mr. Mouat Jones (the Principal). They in Lancashire were particularly glad to see him back at his post after a very long and serious illness.

MR. B. MOUAT JONES, in reply, said the College of Technology felt itself very highly honoured in having been selected as the place for the deliberations of the Iron and Steel Institute, and he thanked Lord Crawford very cordially for the way in which he had proposed the toast.

SIR HAROLD CARPENTER said he was sure they would not wish to separate without his expressing in a sentence their thanks to the Reception Committee for the delightful hospitality that the visitors had enjoyed.

The proceedings then terminated.

BANQUET

A banquet was held at the Midland Hotel on Wednesday, September 18, the Rt. Hon. the Earl of Crawford and Balcarres, P.C., K.T. (President of the Reception Committee), occupying the chair. About 430 members and guests were present.

The Loyal Toast, proposed by the CHAIRMAN, was received with musical honours.

MR. FRED J. WEST, C.B.E., M.Inst.C.E. (Chairman of the Manchester Ship Canal Company), proposing "The City, Port and Trade of Manchester," said that however inadequately he put forward the claims of this toast, he felt sure it would be received by those present with the sincerity and enthusiasm which it deserved.

The City of Manchester had much of which to be proud. Her University College of Technology and her other educational facilities were exceedingly practical. Her social and philanthropic institutions, to say nothing of Manchester's commercial standing and the business acumen of her leading citizens, had placed the city in a leading position of which they were not unreasonably proud.

With regard to the second portion of the toast, the Port of Manchester was the fourth largest in this country, and they brought the largest freight-carrying steamers over the 32 miles of waterway direct to Manchester from all parts of the world. They handled, with imports and exports, something like six million tons per annum, and they had created, in the forty-one years for which the waterway and port had been operating, something like a business world's record, with far-reaching consequences to the commerce and industry of the great areas surrounding Manchester. It was of interest to find that in the early days of the construction of the canal, in 1888, the Iron and Steel Institute paid a visit to the waterway and inspected the progress of the work, and it was still more interesting that the first chairman of the Ship Canal, Mr. Daniel Adamson, who held that post from 1885 to 1887, was President of the Iron and Steel Institute in the year 1887.

With regard to the trade of Manchester, although the city was known to many as "Cottonopolis," and although it was correct to say that it was the centre of the cotton industry, fortunately Manchester had a great variety of trades, and it might be a surprise to many to learn that the engineering trades, in which most of them there were interested, employed more workpeople than the cotton industry itself in the area surrounding Manchester, which was to-day one of the most important engineering centres in the country.

The LORD MAYOR OF MANCHESTER (Alderman Samuel Woollam, J.P.), who was received with applause, remarked that the proposer of the toast was the Chairman of the Manchester Ship Canal, and their Corporation had derived great benefit from the support which it gave in the 'eighties to enable that canal to be completed. The Corporation invested over £6,000,000 of capital in the Ship Canal Company, and he believed that in 1960, of the money it borrowed for that purpose, something like £5,000,000, would have been paid back, and the ratepayers of the city would then enjoy the advantages which would accrue to them from the interest paid on that money.

Continuing, the speaker said that Mr. West, in proposing the toast, had referred from his own personal knowledge and experience to the value of the services rendered by the city's representatives. The value of that service, which was given without stint, could not be measured in words. When he (the speaker) said that they had no fewer than 33,000 persons employed by the Corporation, that they had a rateable value of over £6,000,000, and that three of their trading committees had a turnover of over £3,000,000, it would be realised that those who were privileged to serve as members of the Corporation had some responsibility to bear in connection with its work. Moreover, he thought he could say that there was no city or town in the United Kingdom that gave better value to the citizens for the rates they had to pay, and so long as the citizens felt they were getting value for their rates it must be a source of great satisfaction to the city's representatives.

Concluding, the Lord Mayor said, on behalf of his colleagues on the Council, as well as on behalf of the Lady Mayoress and himself, that it had been a real pleasure to do anything they could to make the meeting of the Iron and Steel Institute a success.

The CHAIRMAN (the Rt. Hon. the Earl of Crawford and Balcarres, P.C., K.T.), who was warmly applauded on rising to speak, said it was a great happiness as well as a great honour to propose the toast of the Institute, the members of which were cordially welcomed to their midst, for it was long since they had had the honour of receiving them. He wished all success and all prosperity to the Institute. They in Manchester well recognised the important task that it fulfilled and the great obligations it carried in the direction and control of the technical side of these leading industries. The importance of the Institute grew day by day as the obligations placed upon the trade and the industry were increased by the State. In wishing success and prosperity to the Institute, they equally wished it to the great industry upon which the security of their country fundamenally depended.

SIR HAROLD CARPENTER, Ph.D., F.R.S. (President of the Iron and Steel Institute), remarked that, as he had mentioned the day before, Manchester had been a good friend to the Institute, especially in its early days when it needed friends; and in their first thirty years of existence they came to Manchester no fewer than three times. He personally came to the city in 1898, 37 years ago, at the very beginning of his career, and, although he was a poor southerner, he chose Manchester as the city from which to begin that career. He had never regretted the choice, and he was convinced he could not have a better one.

When they as an Institute visited a city, they always tried to obtain Papers from local members, and he wished to allude particularly to the very interesting and valuable Paper presented that morning by Prof. Thompson, who was carrying out a very special line of work on wire-drawing, and in fact on the drawing of metals generally, which he (the speaker) was sure was of deep interest and importance to that city. He should also like to pay his tribute to the valuable work which Prof. Bragg was carrying out in the Department of Physics on the structure of alloys. Finally, before sitting down, he wanted to do what he was sure the members of the Iron and Steel Institute would like him to attempt to do, namely to express their thanks to the Reception Committee for the really wonderful time they had given the members and their friends.

MR. JOHN E. JAMES (Chairman of the Reception Committee), replying, said he should like to thank the members for the way in which they had paid tribute to the little effort that had been made to try to give the meeting the success that it deserved. When it was impressed on him that it was about time that the Institute came to Manchester again, he felt considerable diffidence about taking on the responsibility of organising the visit. He should like to say how deeply grateful he was, as a comparative stranger, for the very many kindnesses that he had received on all sides from the leaders of industry in Manchester. Perhaps the outstanding and shining light had been the Lord Mayor. Had it not been for that encouragement, he did not think that it would have been possible for him to carry out the programme. It had been a very great pleasure to arrange this visit of the Institute, and he hoped they would not be so long in returning to Manchester as they were last time. Before he sat down he must pay his tribute to the President of the Reception Committee. Lord Crawford had helped more than he would ever know or admit. He (Mr. James) felt that had it not been for that great grace and charm which was his natural possession much that they had done as a Reception Committee would have been impossible.

THE PARTNERSHIP BETWEEN Messrs. Hugh Currie and Arthur Dewhirst, carrying on business as iron-founders and patternmakers, at Progress Ironworks, New Gate, Mirfield, Yorkshire, under the style of Currie, Dewhirst & King, has been dissolved. Debts will be received and paid by Mr. Arthur Dewhirst, who is carrying on the business under the style of A. Dewhirst & Company.

Cast-Iron Plate Roofing

(*Concluded from page* 236.)

the company is being used for manufacture, and by a perfected method of blocking of the moulds, it is possible to produce these cast-iron plates in numerous variety, meeting all general requirements for high-grade industrial roofing. Specifically, the Usicast plate roof is recommended for installations with roof slopes of not less than 4 in. in 12 in.

This new industrial roofing is composed essentially of two main units—a standard cast-iron plate and cap plate. The former is a single casting $\frac{3}{16}$ in. thick, 52 in. long, and 24 in. wide. In installation, this plate rests on the roof purlins and forms the bulk of roof area exposed to the elements. Each plate unit weighs only 78 lbs., with a factor of safety to support a distributed load of 4,000 lbs., on 4-ft. centres. Installed, the weight averages less than 11 lbs. per sq. ft.

The cast-iron plate is provided with flanges along the longitudinal sides to prevent joint leakage and, at the same time, impart strength to the casting. The hood, likewise adding stability to the cast-iron unit, has been designed to cover the cap plate with a snug fit in the lower course. On the upper side of the roof plate there are two lugs, one at each corner, which engage with the upper roof purlin and facilitate installation. Should these lugs be damaged during the laying of a roof, the construction of the cap plate is such as to prevent any sliding of the roof plate from the purlin. Intermediate cast-iron members are used, comprising modified sections of the standard roof plate. These consist of a half-width roof plate, used for completing alternate courses or staggered courses of the roof; and a short roof plate of identical design, employed where purlin spans are less than 4 ft.

The cast-iron cap plate is semi-cylindrical in shape, of the same length as the roof plate, as will be readily understood. It is provided with a lug, which has a slotted hole for the locking device fastening the member to the upper purlin flange. This lug is near the lower end of the cap plate; in installation, it projects down between the sides of the adjoining standard iron plates and under the purlin flange noted. Lips at each end of the cap plate are for the purpose of securely engaging the flanges of the standard roof plate. Only a few accessories are required for this new type of cast-iron roofing. These include a simple locking device for purlins with flanges down the slope or up the slope respectively; a cast-iron end finisher, used when no end wall exists; ventilator curb castings of two standard types; and ridge roll plates for roofs of sawtooth design.

Assembly Method

The method of assembling the cast-iron plate units is simple, effective and economical. All work is handled from the top and no scaffolding of any kind is necessary. The iron plates are laid in courses, with an overlap of 4 in. between, the joints being staggered. Between each plate on each course, a space of about 1 in. is allowed, the cylindrical cap plate being fastened over this gap, using the lug on the member provided for this purpose.

It is stated that this cast-iron roofing plate can be installed readily by unskilled labour. A foreman and a small gang of, say, three men can lay about 3,000 sq. ft. of surface in an average working day. If at any time after a roof of this type has been laid it is desired to install a vent or a stack, the cutting of the necessary opening or openings in the plates is a simple matter, using an oxy-acetylene torch or drilling a series of small holes with a portable drill. In the event of entire plant destruction or discard, the cast-iron roof has a definite salvage value as scrap material.

The Art of Display at the Foundry Trades' Exhibition

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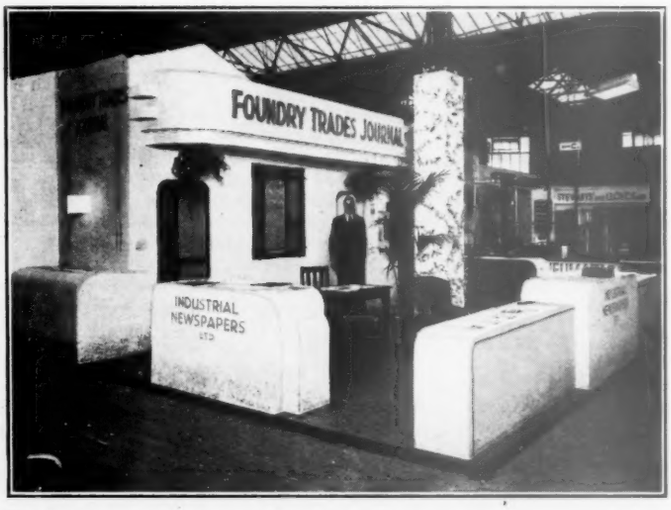

THE FOUNDRY TRADE JOURNAL.

THE INTERNATIONAL MEEHANITE METAL COMPANY, LIMITED.

Sand Problems in a Brass Foundry*

DISCUSSION ON MR. F. HOWITT'S PAPER

MR. A. TIPPER (West Bromwich), in thanking the author for his paper, said he had approached the sand problem from rather a different angle from the usual, but had given opportunities for criticising certain points. For instance, with regard to the interpretation of the curves relating to grain size, it was stated that one could obtain an idea from those curves of the rate of change of grain size; but Mr. Tipper suggested that the shapes of the curves would depend more or less on the apertures of the sieves and might not show the actual variation in size of grains. The shapes of the curves the author had produced were not very different from the shapes obtained by plotting the actual weights of sand between sieve sizes.

There was still much to be said in favour of using cores made with a naturally-bonded sand. The author had advocated using a silica sand with Bentonite in order to obtain certain properties; but naturally-bonded sands, used in moderation, would give very similar properties, and although the permeability was decreased by using a naturally-bonded sand, the difference

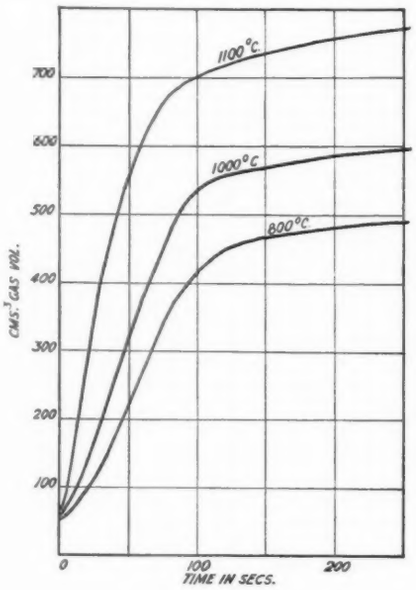

FIG. A.

was not very marked if one used a suitable natural sand. For example, in some tests he had carried out the difference in permeability was only from A.F.A. 120 to A.F.A. 95, whilst the percentage of moisture required in the naturally-bonded sand mixture was actually higher than that required in the Bentonite-silica sand mixture.

With regard to "blowing control," or the measure of the rate of gas evolution from the cores, the author's formula was based on conditions applying to the permeability test, and he had applied that formula, which held good only under certain fixed conditions, to more or less practical conditions in a mould. Mr. Tipper doubted that that could result in producing correct figures. The speaker had measured the actual rate of gas evolution under fixed conditions, and from those figures one could calculate the permeability necessary to allow the gas generated to escape. Those figures could be based on definite laboratory experiments, and gave results which were more easily obtainable and suitable for a method of control than were those obtained by measuring the ratio $\frac{V}{T}$. Rather than calculate a value based on some very variable factors, it was better in his opinion to obtain a figure based only on laboratory conditions for the purpose of control. He would be glad to show to the author some curves indicating rate of gas evolution—and which, by the way, gave values not very different from the values stated in the paper. The author had given a figure of 750 c.c. per minute as representing the rate of gas evolution from an oil sand made with 2 per cent. linseed oil; and in actual measurements it was found that the rate of gas evolution from a core made with a washed silica sand and 2 per cent. linseed oil was 600 c.c. per minute, at a temperature of 1,100 deg. C. as is shown in Fig. A.

MR. BEN HIRD, after expressing his congratulations to the author, stressed the remark made in the paper, "that by studying sand control he had overcome some of his difficulties;" it should be emphasised, he said, that if sand, and sand control were studied from every point of view, many of the difficulties now being encountered would be overcome, or, at any rate, considerably reduced.

Speaking on behalf of the Institute's Sub-Committee on Sands and Refractories, of which he is a member, Mr. Hird asked if the author would describe the apparatus he had used for obtaining his permeability figures from the dry sand cores.

THE PRESIDENT, who commented that Mr. Howitt had been to considerable trouble and had exercised great care in the preparation of the paper, said it was a paper of great importance and one which merited a good discussion. He urged, therefore, that members should make it a point of honour to make written contributions to the discussion.

Author's Reply

MR. HOWITT, replying to the discussion, said he had not studied very deeply the rate of change of grain size. The point raised by Mr. Tipper, that the aperture of the sieve affected the actual figure, was of some importance. He pointed out that in the ordinary graph, on which points were plotted, the mere point afforded no criterion of the way in which grains were distributed. The grains were actually present along a range and not at any given point, and therefore, one required a line in order to picture them.

Bentonite was used in cores, of course, to take the place of the bond in natural sand, and the fact that one was able to add more or less bond brought the matter quite under control, as was very desirable, in any foundry. When using a natural sand, one could not add more or less bond, without corresponding change in permeability.

It seemed that Mr. Tipper was under some slight misapprehension with regard to gas evolution. In the first place, laboratory experiments could not show the rate at which gas was evolved from a core, because one did not know the actual composition of the gases or their temperature, so that one had only the permeability figure to give an idea of the rate at which the gases were involved. Very little was known, of course, concerning the rate of penetration into a sand core; it involved the questions of pouring temperature, the rate of admission of the metal to the mould and the rate at which the heat was transferred to the mould and to the core, so that the rate of penetration was incalculable. In his opinion the best way was to find out by experiment. Most foundries worked under some standard condition, of course, as when making a particular class of work, and under that condition one could get a very fair idea of the rate at which gas was evolved from a certain type of core. Again, many foundries had not a laboratory and had not facilities for ascertaining the rate of gas evolution. However, he would be glad to discuss the matter further with Mr. Tipper, and was pleased that it had aroused interest. Finally, he promised that he would describe in writing the apparatus which he had designed and made for his work.

Written Reply to Mr. Hird

In response to Mr. Hird's request for a description of the method used to measure the permeability of the actual cores, this is done in the following manner:—

A plaster impression of the pattern, complete with prints, is first made in two parts. This, of course, is precisely similar to the mould except that it is impermeable. The corresponding core is then placed in one half, the other half placed over it and clamped. Mercury is introduced into the space between the core and the plaster through a suitable orifice in the top. It is necessary to seal the joints between the core and plaster which is accomplished by a rubber ring around the core print or by plasticine or other plastic material. The joint between

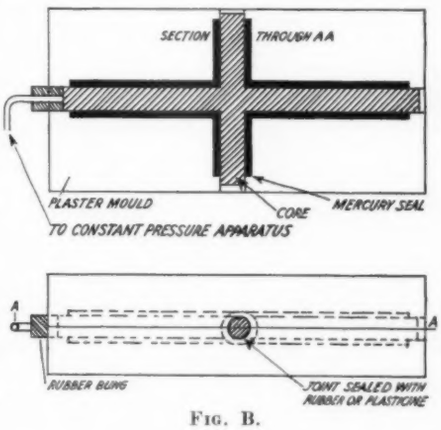

FIG. B.

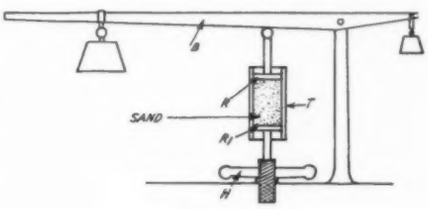

FIG. C.

the two halves of the mould is sealed with thick oil or grease. Reference to the accompanying diagram will make this quite clear (Fig. B).

This device is then connected to an aspirator arranged to deliver air at constant pressure and a suitable volume passed through the system. The time taken and the fall in pressure across the specimen are measured, which together with the dimensions of the specimen are all the data required to calculate its permeability.

If required the experiment may be made between certain parts of the core by stopping up such of the inlets as are not required. Alternatively, in order to study the permeability of certain individual parts, the core may be broken and suitable portions introduced into rubber bungs which are connected to the constant pressure apparatus. This method has the disadvantage that the experiment cannot be pursued to its logical conclusion by making castings with the tested cores, although it may yield valuable information.

The ramming of green sand specimens is done on a machine which consists essentially of a

(*Concluded on page* 244.)

* See FOUNDRY TRADE JOURNAL, July 4, 1935, p. 9.

Loam Moulding

By G. PLATT

Loam moulding is a special branch of founding which calls for all the resources and skill that a foundryman can have at his command; it is, in fact, an art in itself, although to the inexperienced eye it seems a crude method of making a mould. To be a good loam moulder one must be clear-headed, and able to think out the best and safest method of constructing any job one is likely to encounter.

The principal advantage loam moulding has over other methods is that the biggest and heaviest of castings can be made with safety without incurring much cost in the patternshop. The simplest of tackle used in loam moulding consists of socket, spindle, shear irons and striking or strickling up boards. No full and complete patterns are used in this section of moulding, skeleton patterns, and in many cases drawings, with strickling boards are all that are provided to make a mould, therefore it is a great advantage to a loam moulder if he can read a drawing, and draw off his own job, otherwise he must depend upon the patternmaker. In cases where large castings are required, it would be too costly to make a complete pattern, or if such were provided, to make a good mould or casting from it, that is, a casting that satisfies and pleases the eye of a good foundryman.

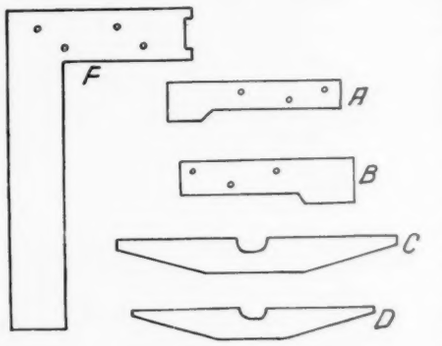

FIG. 1.

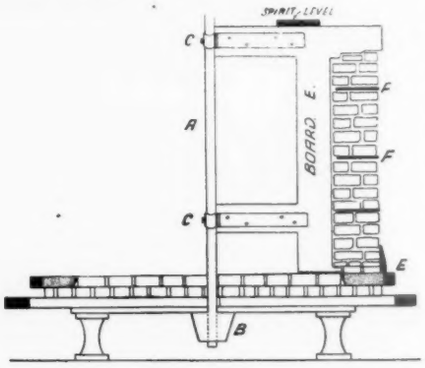

FIG. 2.

Work of cylindrical or spherical section is best and cheapest when struck up in loam, especially where one or two off are required.

Fig. 1 indicates all that is required for the making of a simple loam mould. A is the sweep for the striking up of the bottom plate; B for the top plate; C and D are the mould and core gauges; E the striking-up board for the mould, shown on Fig. 2; F is the core board. These represent the total cost of patternmaking for this job. Reference to Fig. 2 shows that the spindle "A" revolves in the socket "B." This socket, which is supported by stands, is perfectly level. Attached to the spindle are the shear irons "C," which are movable and can be adjusted to any height. Fastened with bolts to the shear irons, is the striking board E; the edge of the board is tapered as are all striking boards. Its outline takes the shape of the casting except where the top and bottom joints are marked; the board is cut out to fit round the collar of the shear irons, and fits close up to the spindle. This gives the casting its own radius, or the required radius, but the radius of the board and the radius of the spindle added together equal the radius of the casting.

To start this job a strong bottom plate is required capable of carrying or withstanding the whole weight of the job, and the pressure of the metal. This plate (Fig. 3) is cast in an open-sand bed, and is struck up with strickles, no pattern being used. A hole is cast in the centre of the plate, which requires to have four lugs for carrying purposes and for clamping the whole job together before casting. The plate is then laid on the socket which has been set level. The hole in the centre of the plate comes to the hole in the socket which has been bored to meet the tapered end of the spindle and into the socket hole and the spindle fitted in. A square is then rested against the spindle and a level is put on the top edge of the square. This is done in three places round the spindle, and if it indicates a level condition in each case then the spindle is at right angles to the plate, but if this is not so, pieces of packing must be put beneath the socket until it is level.

The plate is then claywashed, loam is laid on, and then bricks are placed on leaving a space of about an inch all round each brick. These spaces are then filled with small cinders, and the centre round the spindle is stopped off with loam and evolved gases and steam are allowed to escape around the outside ring of bricks. This is shown in Fig. 3 and constitutes a reliable method of laying brick work to prevent scabbing on a flat surface on which fluid iron must rest.

Sweep A is then adjusted to a shear iron, tried with a spirit level, and another layer of loam and bricks is laid, leaving a clearance of about ¾ in. between the face of the bricks and the sweep. The clearance is filled with loam, first with a stiff loam which is dried with a fire as the laying progresses, and then with a slip loam which has been passed through a sieve with a little more water added. This then finishes the bottom part. After the bottom part has been dried it is blackwashed and parting sand strewn on while the blacking is wet.

Building the Mould

A cast-iron ring with strong prods round the outside is made, this also having lugs for lifting. The inside diameter of the ring is about 3 in. larger than the diameter of the casting, which leaves a clearance round the face of the mould and the edge of the ring of 1½ in. The edges of the plate must not come to the face of the casting or mould on account of contraction. If the underside of the plate is level it can be put in position on the bottom part. If it is not level, it is claywashed, and a layer of loam laid on the bottom part of the plate, being pressed well down on to the loam. Board E, Fig. 2, is then attached to the shear irons and fixed to the spindle, then being tried with the gauge stick, made level, and the clearance seen to between the edge of the board and the ring. Building is then commenced.

It is as well to use loam bricks for building round the bottom flange shown in Fig. 2, as they will crush under contraction easier than the common bricks. They are also a means of venting. When building the wall of bricks as wide a joint as possible is made between each brick as all venting must be done through the joints, also each brick must bind one with another much in the same way as a wall built by a bricklayer. An example of this can be seen on Fig. 4. If only a double course of bricks are laid, the vents are carried off with straw bands inserted at intervals round the wall and brought to the outside. If more than two courses of bricks are laid, cinders may be dropped in spaces left behind the first course of bricks, and they are also brought to the outside course of bricks.

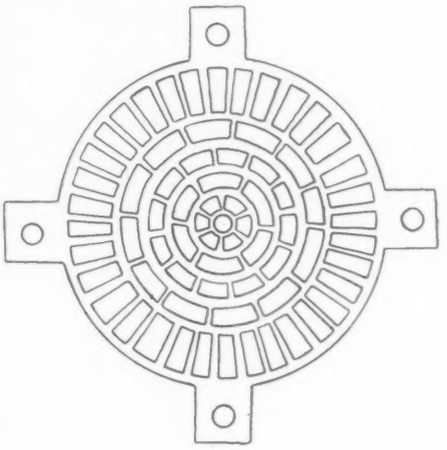

FIG. 3.

Building rings are laid on about every four courses of bricks or as judgment decides. The rings are clear of the face of the mould by about 1½ in. These rings are set wider apart as the top is reached; the rings can be seen at "F," Fig. 2. During the building, a clearance of about ¾ in. is made between the face of the brick wall and the strickle, a strong stiff coat of loam being then rubbed well into the wall. A very slight clearance is kept between the loam and the strickle, as the laying on of loam is in progress. It is dried or stiffened by means of a fire, a final finishing coat of sieved loam being then rubbed on, and by slowly drawing round the sweep the required impression and diameter for the casting is left.

The board when building may be used freely both ways, that is backwards and forwards, but when finishing, it must only be drawn forwards, as when drawn backwards the sharp edge will pull the loam off again, but the tapered edge on the front of the board when drawn forward allows the slip loam to run through and put a complete finish to the face of the job. Thus far the mould is shown on Fig. 2. The next stage is the building of the core, after which the mould is taken away from the bottom of the course, lifting being done by means of the lugs shown at "E."

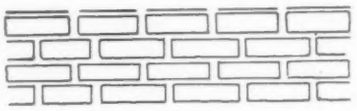

FIG. 4.

Core Preparation

The building of the core (Fig. 5) is effected so that it will be attached firmly to the bottom of the mould. The building commences after fixing the core board, it only being possible to use one shear iron because the building this time is inside the board and not outside, as in the case

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of the mould. About four rows of bricks are laid at the bottom to strengthen the core and to resist the greater pressure of metal at the bottom. Small cinders are inserted between the bricks for vents, and the building is carried on in the same way as the mould, a strengthening ring being fixed in at the top to stop it from warping. The top plate (Fig. 6) is then commenced.

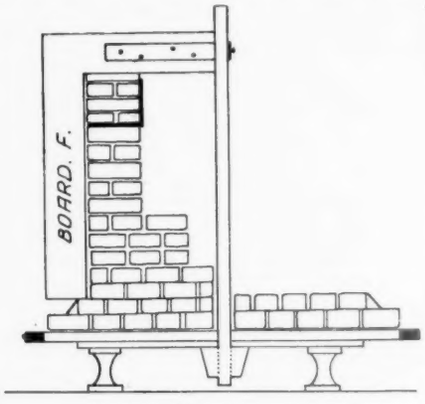

FIG. 5.

This plate is cast with small prods over its surface to hold the hanging loam when the plate is turned over. The runner and riser holes are also cast in it, the centre hole is sufficiently large to allow the top part of the core to pass through when closed, both diameters being made the

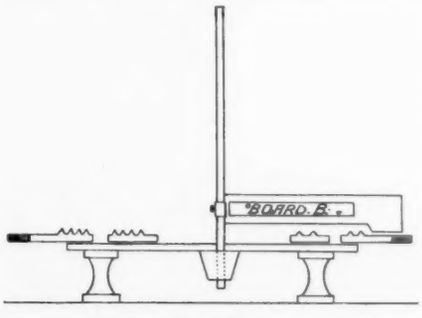

FIG. 6.

same. Four lugs are also cast on as a means of clamping the whole of the job together before casting. The plate is claywashed, a piece of straw rope spliced and strewn from the plate, loam is spread over in a stiff condition and a finishing coat of loam is swept on, under the strickle B, Fig. 1. When the job has been dried, runners and risers are made in the top plate and the whole job is blacked.

The drying of a loam mould is of great importance. A quick drying generally results in the cracking and distortion of the loam. The best method is to allow the mould to dry slowly in a slow stove. Finally, to assist the gases to escape when casting, shredded peat, horse manure and chopped straw are mixed with the loam.

Sand Problems in a Brass Foundry

(*Concluded from page* 241.)

counterpoised beam (B), Fig. C, which is allowed to rest on a roller secured to the ramming head (R). In vertical alignment with R is another ram (R_1), the connecting rod of which extends downwards and is threaded to pass through the handwheel (H). Weights of any desired size are hung from (B) so that the force applied to the ram may be of any required magnitude.

In use, a quantity of sand is placed in a tube (T) which is introduced between the two rams and into which they fit. Load is applied by turning the handwheel so that the ram (R_1) moves upwards thereby compressing the sand against the ram (R). When the sand is compressed as far as possible under the particular force applied, the whole system of tube, sand and rams commences to move upward, which movement is indicated by a pointer attached to the beam (B). The load is then removed, the tube disconnected and the specimen extracted from it. The tube may be hinged to facilitate the extraction.

This particular machine was adopted in order to make possible the study of the properties of sand under various conditions of ramming. It is none the less suitable for routine testing, since the sequence of operations occupies only a few seconds and the force applied may be adjusted to correspond with that used on the moulding machines.

Mr. Hird's Written Discussion

MR. HIRD wrote that he thanked Mr. Howitt for his description of the apparatus he used for testing dry sand; also his ramming machine for green-sand specimens. The methods were ingenious, but had little or no comparison with standard practice of sand testing; therefore, it was almost impossible to correlate results with other data. Considerable expense and time must be entailed in making and using the plaster-of-paris formers if a number of cores of different types required investigation. The permeability of sand could be obtained from a simple straightforward standard test-piece of standard density. Variations of density due to different methods of ramming in the foundry would remain a subject for close supervision, whether the test-piece was in the form of the actual core or the standard test-piece. Therefore, except for experiments and investigations, he thought the standard apparatus was preferable and far more reliable.

Author's Written Reply

Mr. Hird's somewhat sweeping criticism was, he felt, hardly justifiable. It should be pointed out that the apparatus was originally designed solely for research purposes, and not as Mr. Hird appears to think, for routine work. Mr. Hird states that the methods had little or no comparison with the standard practice of sand testing, and up to a point he is correct. It was deemed advisable to obtain some information on the behaviour of sand under the conditions obtaining in actual practice, which information could not be obtained by arbitrary methods. It was not suggested that the methods were in any way supercessionary, but they could give much information which was unobtainable otherwise, and provided the means to maintain the close supervision which Mr. Hird points out was necessary. The permeability of a standard specimen was not necessarily that of a core or mould made from the same sand, and it was necessary to know in what degree they differed and to work with actual data. Otherwise the properties would not respond to systematic treatment.

Electric Resistance of Ferromagnetic Substances

TOKUTARÔ HIRONE, in a Paper "A Simple Theory on the Anomaly of Electric Resistance of Ferromagnetic Substances," in the Science Reports of the Tohoku Imperial University, points out that this anomaly is explained by the fact that the mean free path of the conduction electron is affected by the rotational vibration of molecular magnets in the Honda-Okubo model of ferromagnetic substance. It is also to be noted that the equation of corresponding states exists between the reduced resistance and the reduced temperature of the ferromagnetic substance. This conjecture has been confirmed by the results of measurement upon iron, cobalt and nickel.

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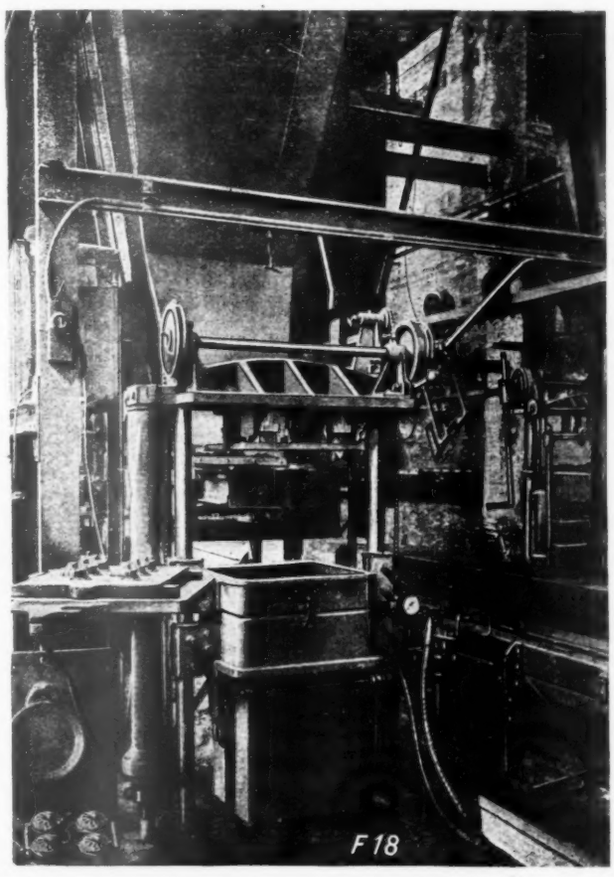

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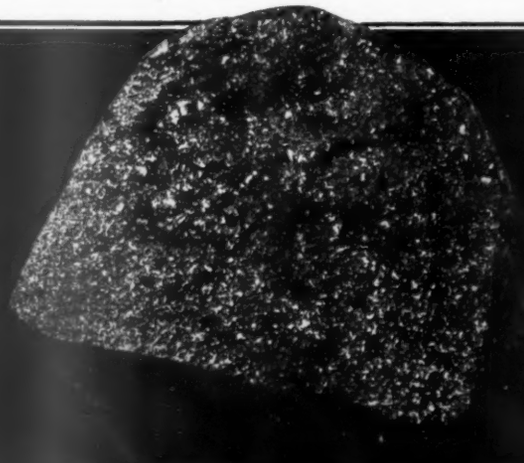

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This Week's News in Brief

Trade Talk

THE FISHERY BOARD FOR SCOTLAND has ordered a 57-ft. patrol cruiser from Messrs. J. N. Miller & Sons, Limited, St. Monance. The boat will be fitted with twin engines of the Gleniffer-Diesel Company.

AN ORDER for fifteen 2-4-2 type locomotives for the Egyptian State Railways has been placed with Messrs. Sir W. G. Armstrong, Whitworth & Company (Engineers), Limited, of Scotswood, Newcastle-upon-Tyne.

MESSRS. JAMES HOWDEN & COMPANY, LIMITED, engineers, Glasgow, have received an important contract from Germany. The contract is for a complete equipment of Howden's patented turbulent-flow air preheaters for the boilers of five cargo steamers which are being built in German shipyards.

THE UNION STEAMSHIP COMPANY, New Zealand, have placed an order with Messrs. Alexander Stephen & Sons, Limited, Linthouse, for a motor cargo vessel. The new vessel, which will have a tonnage of 3,500, will be specially designed for the owners' coal and timber trade between New Zealand and Australia.

BLYTHE COLOUR WORKS inform us that their sales of enamels for cast and sheet iron are increasing tremendously and are double what they were two years ago. Their 5724 "direct on" cast iron which can be used with any colour is very popular, and their 351 acid proof has supplied a long felt want, as it can be applied most successfully on stoves, etc., and the number of users are increasing weekly.

A GIANT PROPELLER has been cast in iron by Messrs. Andrew Strang & Company, Blair Foundry, Hurlford, Ayrshire, for Messrs. Charles Salvesen, of Leith. The propeller is 17 ft. 9 in. in dia., and weighs 10½ tons. The surface area is 115 sq. ft., only 3 ft. less than the propellers which have been fitted to the "Queen Mary." The new propeller is to be fitted to a relief ship serving whalers in the Arctic.

HOLDERS OF THE 6 per cent. first debentures of Messrs. John Brown & Company, Limited, which are due to be redeemed on April 1 next, have been notified of an offer of immediate redemption. The directors, in a circular, state that they believe it would be more convenient to holders if the moneys due up to and including the date of redemption were made immediately available for reinvestment. They are therefore prepared to pay off such debentures on September 30 next at the rate of £106 4s. in respect of each £100 debenture.

THE RECORD NUMBER of 13,000 free sites have been offered by foreign and Empire countries for the display of the poster for next year's British Industries Fair, which opens in London and Birmingham on February 17. The now well-known theme of Britannia and her trident with the key (of prosperity) and the B.I.F. design above particulars about the Fair has been effectively rearranged by the artist, Mr. Tom Purvis, in blue and red. Batches of the new poster are being sent abroad to 86 countries this week, printed in French, German, Spanish, Italian, Portuguese, Dutch, Swedish, Danish and Polish, as well as in English.

THE FRENCH "Journal Officiel" of August 27 contains a Decree, dated August 18 and effective on publication, which prohibits provisionally the export and re-export (after warehousing, transit or transhipment) of waste and scrap of pure or alloyed copper; filings of lead; old manufactures and scrap of old manufactures of lead, filings of pure or alloyed tin; old manufactures and scrap of old manufactures of pure or alloyed tin; filings of zinc; old manufactures and scrap of old manufactures of zinc; filings of nickel and old manufactures and scrap of old manufactures of nickel. Exceptions to the above prohibition may be granted under conditions to be fixed by the Minister of Finance.

Obituary

MR. JOHN ROBB, who died last week in his 67th year, was employed for some time at the Dens Iron Works of Alexander Shanks & Son, Limited, and up to five years ago worked in the moulding department of James Keith & Blackman Company, Limited, engineers, Arbroath.

Contracts Open

India, October 15.—Coupling rods, for the Controller of Stores, N.W. Railway, Lahore. The Department of Overseas Trade. (Reference T.Y. 5,291.)

Horsham, October 2.—Cast-iron water mains, fittings, valves, etc., of various sizes, for the Rural District Council. The Water Engineer, Council Offices, 14, Carfax, Horsham.

Uttoxeter, September 30.—667 yds. of 12-in. dia. cast-iron hydraulic main outfall sewer, for the Urban District Council. Messrs Willcox, Raikes & Marshall, 33, Great Charles Street, Birmingham. (Fee £5 5s., returnable.)

Haslemere, September 28.—One fuel or semi-Diesel crude oil engine of approx. 75 b.h.p., for the Urban District Council. Mr. C. A. Best, surveyor and water engineer, Council Offices, Museum Hill, Haslemere, Surrey.

Buenos Aires, October 17.—Eight steel bridge spans of 5.50 metres each and one steel bridge span of 10.80 metres, for the Argentine State Railways Administration. The Department of Overseas Trade. (Reference T.Y. 5,282.)

Leeming Bar.—2,500 lineal yds. of 9-in., 8-in. and 6-in. cast-iron pipe sewers, manholes, etc., for the Bedales Rural District Council. Messrs. D. Balfour & Sons, 3, St. Nicholas Buildings, Newcastle-upon-Tyne. (Fee £3, returnable.)

Stockport, October 7.—Cast-iron pipes, 18-in. and 15-in. dia. forming trunk mains, for the Waterworks Committee. Messrs. G. H. Hill & Sons (Manchester), civil engineers, 40, Kennedy Street, Manchester. (Fee £3 3s., returnable.)

Axholme.—Cast-iron and spun-iron pipes, specials, etc., to British standard specification, for the Isle of Axholme and Crowle Joint Water Committee. Messrs. J. H. Haiste, Middleton Chambers, Lowgate, Hull, or Messrs. Fairbank & Son, Barclays Bank Chambers, St. Helens Square, York.

West Lancashire, October 7.—Two sets of electrically-operated automatic sewage pumping plant and two sets of electrically-operated automatic screening plant, for the West Lancashire Rural District Council. Mr. H. B. Ward, 26, North John Street, Liverpool, 2. (Fee £5 5s. each contract, returnable.)

Exeter, September 28.—3,420 yds. 14-in. and 5,490 yds. 9-in. dia. spun-iron pumping main and 3,210 yds. 6 in. dia. spun-iron trunk main, including excavation, reinstatement, construction of culverts, river crossings, sluice valves, air valves, fire hydrants, the construction of chambers and other contingent works, for the Town Council. Mr. R. H. Dymond, city engineer and surveyor. (Fee £5, returnable.)

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Rotherham Metals, Limited, 4, Clement's Inn, Strand, W.C.2.—Capital £10,000 in £1 shares. Metal merchants, etc. Directors: H. W. Bryant, J. H. Devine, J. R. Tierney and J. W. Thompson (chairman).

Radiography of Austenitic and Martensite

In a Paper "X-Ray Investigation of Austenite and Martensite in some Special Steels," in the Science Reports of the Tohoku Imperial University, ZENJI NISHIYAMA describes the radiographic analysis of the crystal structure of austenite and martensite in special steels containing chromium, nickel, or manganese. It was found that the austenite has a face-centred cubic lattice, and the martensite in quenched steels or in steels water-quenched and cooled in liquid nitrogen has a body-centred tetragonal lattice. Their lattice-constants vary with carbon content in the same way as in the case of carbon steel. The martensite-like structure in quenched and tempered high manganese steel is not the same martensite as in carbon steel, but it consists mainly of hexagonal phase to be found in the binary alloy of iron and manganese.

Personal

MR. J. BORTHWICK, of the staff of the Singer Sewing Machine Company, Clydebank, has been appointed to organise the office staff at the firm's new factory at Monza, Italy.

MR. JOSEPH COWAN, foreman in the iron-dressing department of Messrs. Glenfield & Kennedy, Limited, Kilmarnock, has been presented with a signet ring and umbrella by the employees in recognition of his having completed 47 years' service with the firm.

MR. JAMES RANKIN, cashier of Messrs. P. & W. MACLELLAN, LIMITED, iron and steel merchants, Trongate, Glasgow, has been presented with an umbrella and a pen and pencil set by the counting-house staff, in recognition of his completing over 50 years' service with the firm.

MR. GEORGE PATE, B.Sc., M.I.A.E., managing director of Albion Motors, Limited, Glasgow, has been appointed chairman of the firm, in succession to the late Mr. Norman O. Fulton. Mr. Pate is the eldest son of Mr. George Pate, O.B.E., manager of the Carron Company, of Falkirk.

MR. F. F. KERRISON, who has been awarded the Order of the Nile (fifth class) by the King of Egypt, in appreciation of his services as assistant dockyard manager at Khartum North, Sudan, served his apprenticeship with the firm of Douglas Fraser & Sons, Westburn Foundry, Arbroath.

Wills

FULTON, NORMAN O., joint managing director and chairman of Albion Motors, Limited, Glasgow	£141,390
RICHARDSON, G. B., of Jesmond Park, Newcastle, a director of Messrs. Swan, Hunter & Wigham Richardson, Limited	£77,409
COLES, W. J., of Sheffield, a director and head of the engineering department of Messrs. Edgar Allen & Company, Limited, steelmakers and engineers ...	£3,653

Company Reports

Coltness Iron Company, Limited.—Interim dividend on the ordinary shares of 5 per cent.

Thos. W. Ward, Limited.—The directors announce that the arrears of dividend on the second preference, including employees, share capital of the company for the year to June 30, 1935, together with the current quarter's dividend on the same shares and the quarter's dividend on the first preference share capital will be paid on September 30.

Qualcast, Limited.—Net profit for the year ending June 30 last of £45,239 is a record for the company, and is at the rate of 32 per cent. on the ordinary capital after paying the preference dividend. The volume of output was the largest ever handled. The directors have erected a further extension equipped as a steel foundry. This came into experimental operation during last month. The balance available is £62,308 19s. 8d. A final dividend of 10 per cent., making 15 per cent. for the year, together with a cash bonus of 5 per cent., absorb £14,531, and £47,777 is carried forward. Meeting September 24.

Davy Bros., Limited.—The report for the year ended March 31, last states that during the major portion of the period the company was being managed by a receiver and only in June last did the reconstruction scheme—authorised by the meetings in April become effective. The loss for the year, amounting to £15,036, is attributable to non-recurring charges of £5,600 for bank and debenture interest, and losses on certain large orders for new types of machinery which involved special expenditure. The cancellation of the debenture stock, the adjustment of the company's capital on a rational basis, and the provision of the new finance have enabled the company to eliminate past losses, write down the fixed assets to a thoroughly conservative figure, and make provision for modernising the plant. There is definite evidence that the company has maintained its reputation with the trade, and the activity in the heavy steel industry is such that the board feel they can look forward with confidence to the future progress and development of the company. The annual meeting on October 7 will be followed by an extraordinary meeting to adopt new articles of association.

XUM

PRELIMINARY ANNOUNCEMENT

Rumour is persistent concerning the

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F E L

CONTINUOUS SAND MIXER

An announcement will be made shortly.

NEW SAND OLD SAND COAL DUST

all accurately and automatically measured.

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HALIFAX, YORKS.

Telephone: 61459 Halifax. Telegrams: "FEL" Halifax

Raw Material Markets

The output of steel for this year will, in all probability, reach a new high level. Good employment throughout the autumn is assured for the iron and steel works in dealing with their present commitments. No alteration in prices has yet been made, and even if a change were made it would be some considerable time before it affected buyers, most of whom are well covered. However, the chances of an alteration in prices must not be overlooked, and any further advance in the costs of manufacture would certainly have that result.

Pig-Iron

MIDDLESBROUGH.—The amount of new business has not increased to any great extent, but all the output has been sold for several months ahead. A considerable expansion of the demand could only be met by lighting more blast furnaces. Scottish foundries continue to inquire for large tonnages of Cleveland iron, but export customers offer prices which are not attractive to local producers. Home quotations are all on the basis of the fixed minimum schedule, No. 3 Cleveland G.M.B., the standard foundry grade, being 67s. 6d. per ton to buyers in the Middlesbrough area, 69s. 6d. on the North-East Coast, 67s. 3d. in Falkirk and 70s. 3d. in the Glasgow area. No. 4 foundry and No. 4 forge irons are still 1s. cheaper than No. 3 and 2s. 6d. per ton extra is charged for No. 1 quality.

A large proportion of the local production of hematite continues to be taken up by local steelworks, and there is no shortage of inquiries for any that remains. The price of East Coast hematite to Scotland has been adjusted to 74s. per ton delivered, and, as a result, increased business is expected. A cargo of hematite has recently been despatched to Italy, and it is pleasing to hear that some of the outstanding debts have been reduced. Export quotations are as follow:—No. 1 quality, 71s. per ton delivered Middlesbrough, 72s. on Tyneside, 73s. 6d. elsewhere on the North-East Coast, 74s. in Scotland, 78s. 6d. in Sheffield, and 84s. 6d. in Birmingham.

LANCASHIRE.—Most of the foundries are well covered in their pig-iron requirements, and few inquiries for large tonnages are in circulation. Regular tonnages are being consumed by Lancashire engineers, machine-tool makers and the heavy electrical industry. The light-castings trade, which has been taking up good quantities of pig-iron for several months, is still well in the market, but it would not be unexpected if a decrease in their requirements were noticed shortly. Staffordshire, Derbyshire and Lancashire brands of No. 3 pig-iron for delivery in the Manchester zone are on the basis of 74s. per ton, Northants at 72s. 6d., and Scottish foundry iron at about 81s. 6d. per ton. Hematite prices are firm, East Coast being at from 80s. to 81s., and West Coast at around 81s. per ton, including delivery in the Manchester area.

MIDLANDS.—A satisfactory level of consumption has been maintained this month in this district, and the light foundries and the general engineering concerns have been particularly prominent in their requirements. Most of the ironfounders are well covered for some months ahead and, consequently, the amount of new business is strictly limited. Prices are unchanged on the week, the controlled levels for Midland foundry irons, ordinary quality, including delivery to Birmingham and Black Country stations, being 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and Staffs No. 3. Large consumers receive a small graduated rebate. General engineers and jobbing foundries are well employed and there are possibilities of an improvement as the autumn advances. Refined iron is quoted at between £5 7s. 6d. and £7, low-phosphorus pig-iron, including Scottish No. 3, is 85s. to 90s., and medium-phosphorus is 72s. to 82s. 6d. per ton, these quotations being inclusive of delivery to the Birmingham zone. Supplies of hematite pig-iron are being despatched at a satisfactory rate, but it will be some time before there is any further buying, owing to transactions arranged previous to the price revision. West Coast hematite is at 84s. 6d. per ton for mixed numbers, delivered this district. East Coast No. 3 is 84s., and Welsh mixed numbers 83s. per ton.

SCOTLAND.—Prices of pig-iron in this area are firm and, on the whole, conditions are satisfactory. No. 3 foundry iron remains at the recently advanced figure of 70s. per ton at furnaces and for No. 1 the price is 72s. 6d. The export trade has decreased to an almost negligible amount. The official prices for Cleveland iron are unchanged, No. 3 being at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow. Steel-making irons are being taken up in satisfactory tonnages and are at the following prices:—Mixed numbers Scottish hematite, 71s. to 73s. 6d.; mixed numbers West Coast hematite, 74s.; ordinary mixed numbers East Coast hematite, 74s.; basic, British and Indian, 70s., less 5s. rebate, all f.o.t. steelworks here.

Coke

This market has now taken a definite turn towards more normal conditions and many ironfounders have covered their winter needs. For delivery in the Birmingham area, best Durham coke is on offer at between 37s. 6d. and 40s., with other grades down to 35s. Welsh coke is at from 41s. 6d. to 43s. 6d. and Scottish low-ash coke may be obtained in limited quantities at 39s. to 41s. per ton.

Steel

Steady conditions continue to rule in the steel market, and while the volume of new business is expanding rather slowly, this is attributable to the heavy forward contracting which took place a few weeks ago, says the official report of the London Iron and Steel Exchange. Practically all departments of the industry are well employed, and in some cases are working almost at capacity. Export business appears to be slowly improving in spite of obstacles in the shape of import quotas and exchange restrictions. An active business continues to be transacted in semi-finished steel, and considerable pressure is being exercised by consumers to obtain delivery. Although imports of Continental semi-finished steel are reaching this country in fulfilment of the Continental quota, no fresh offerings are being made and no sales are likely to take place for some weeks. Business in all departments of the finished-steel market is active, and the tendency is for the demand to strengthen as the autumn trade develops. Home market requirements are well maintained, and heavy deliveries of manufactured steel are being made to the consuming industries. There is also a fair volume of export business, and the inquiry from overseas appears to be steadily expanding.

Scrap

Home supplies of scrap in the Cleveland area are quite sufficient to meet the needs of consumers. Heavy melting steel at 52s. 6d. per ton, delivered, is in good demand, but sellers continue to be rather cautious in disposing of machinery cast-iron scrap at 54s. per ton. Ordinary heavy foundry cast iron is at 52s. 6d. and 42s. 6d. per ton is offered for light metal. Cast-iron borings are on offer at 27s. 6d., delivered works. The Midland market continues to have a steady appearance and consumers are able to satisfy all their needs at present prices. An increase in prices would not be surprising owing to the increasing demand from other districts. Cast-iron scrap has a steady following and heavy machinery metal, in cupola sizes, is at 55s. to 57s. 6d. Short heavy steel scrap as used in the foundries is at 55s. per ton, delivered. Encouraging reports are current in the Lancashire market and but for supplies of steel scrap coming in from the United States the prices would be considerably higher. Heavy melting steel scrap is being quoted up to 54s. per ton, delivered Sheffield basis, while wrought-iron scrap is at from 55s. to 57s. 6d. per ton, delivered to Lancashire works. A good consumption of scrap material is reported in Scotland and firm prices rule. Ironfoundries are able to obtain their requirements easily and at current quotations. First-quality heavy steel melting scrap in furnace sizes is at 50s. per ton, and good, piling wrought-iron scrap is at 60s., with special quality around 62s. 6d. Machinery cast-iron scrap is at 56s. 6d. to 57s. 6d. per ton, while light cast-iron scrap is at 40s. delivered.

Metals

Copper.—The tone of this market has been very firm this week and extensive business has been transacted, both in standard and refined copper. The reason for this is, undoubtedly, the increase in the American price of domestic copper to 9 cents per lb. In spite of the rise in the amount of business, prices, in this country, have not seen any unusual change. The position on the United States market is interesting. According to the weekly market report issued by Messrs. Brandeis, Goldschmidt & Company, Limited, "business has been very active in America. Considerable purchases continued to be made at 8½ cents even after the rise in the market, as many buyers were in possession of time offers which had not expired. The market, however, is now firmly established at the higher level. Sales have been reported as high as 35,000 short tons during one day, but this quantity is, of course, out of all proportion to the actual rate of consumption and represents large anticipatory purchases. It is estimated that so far during September sales in the United States have been in excess of 75,000 tons."

Daily market prices:—

Cash.—Thursday, £34 8s. 9d. to £34 11s. 3d.; Friday, £34 11s. 3d. to £34 12s. 6d.; Monday, £34 10s. to £34 11s. 3d.; Tuesday, £34 8s. 9d. to £34 11s. 3d.; Wednesday, £34 16s. 3d. to £34 17s. 6d.

Three Months.—Thursday, £34 17s. 6d. to £34 18s. 9d.; Friday, £35 to £35 1s. 3d.; Monday, £34 17s. 6d. to £34 18s. 9d.; Tuesday, £34 16s. 3d. to £34 18s. 9d.; Wednesday, £35 2s. 6d. to £35 3s. 9d.

Tin.—Increased activity has been noted on this market and a better demand has led to a rise in prices. The call for tin from the United States is restricted in view of the fact that the tinplate mills are only working at 55 per cent. of capacity. There is very little demand for tin from Continental sources, but that is to be expected until more settled political conditions prevail.

Day-to-day fluctuations:—

Cash.—Thursday, £227 2s. 6d. to £227 5s.; Friday, £226 15s. to £227; Monday, £225 15s. to £226; Tuesday, £224 15s. to £225; Wednesday, £227 to £230.

Three Months.—Thursday, £214 10s. to £214 15s.; Friday, £215 2s. 6d. to £215 7s. 6d.; Monday, £214 5s. to £214 10s.; Tuesday, £213 10s. to £214; Wednesday, £214 10s. to £215.

Spelter.—Prices of this metal are maintained, and if the present demand continues there is every possibility of a new high record being made for the current year. The price of spelter in the United States has also advanced and fair quantities are being consumed by the brass mills and the motor-car industry. Stocks in the United States are still large, but it is hoped that an expected increased demand will lower them considerably.

Official quotations were as follow:—

Ordinary.—Thursday, £15 11s. 3d.; Friday, £15 7s. 6d.; Monday, £15 10s.; Tuesday, £15 10s.; Wednesday, £15 18s. 9d.

Lead.—In common with the other base metals, lead has presented a firm tone this week, though industrial demand has been rather quieter. The world output in July was 114,847 metric tons, while, according to the Metallgesellschaft, the output in June was 106,529 tons. The German average monthly lead output decreased during June and July from over 10,000 tons to below 9,000 tons.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £16 10s.; Friday, £16 11s. 3d.; Monday, £16 12s. 6d.; Tuesday, £16 17s. 6d.; Wednesday, £17 3s. 9d.

Applications for Trade Marks

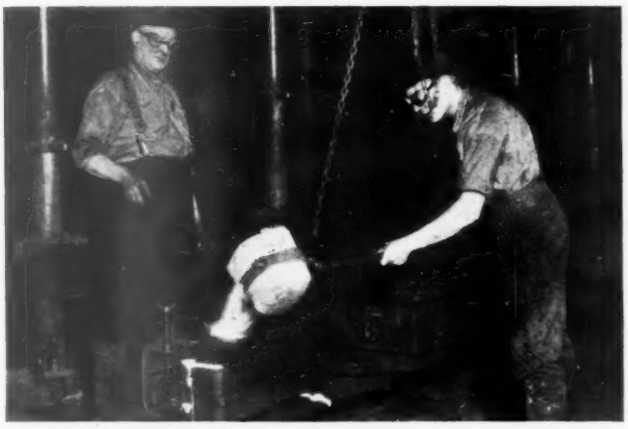
The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"NORAL."—Sheet aluminium and aluminium castings (in the rough); finished moulded and finished cast articles of aluminium included in Class 14. Northern Aluminium Company, Limited, Bush House, Aldwych, London, W.C.2.

"PARADYNE." — Electric-arc-welding apparatus. Metropolitan-Vickers Electrical Company, Limited, Kingsway, London, W.C.2.

Application to the Cutlers' Company, Sheffield.

"KO-KROM."—Chrome steel. Darwins, Limited, Fitzwilliam Works, Templeborough, Sheffield.



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Pouring of Cylinder-Blocks in the Ford Foundry.

Advantages of Ford Machine-Cast Pig Irons

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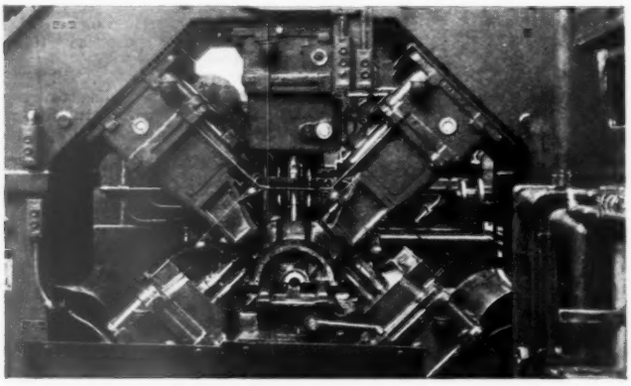
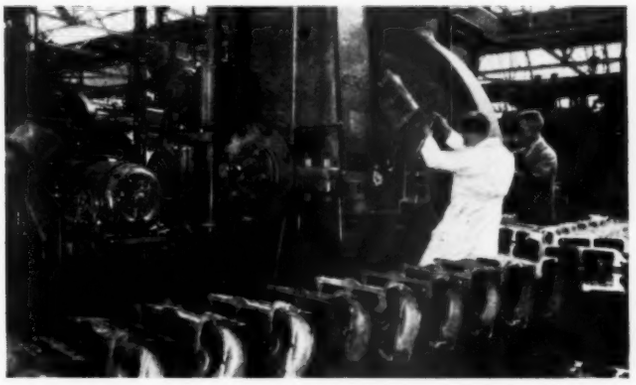
2. Cast in Convenient Sizes for Charging.
3. Made to Narrowest Specification-Limits.

FORD MOTOR COMPANY LIMITED,
DAGENHAM, ESSEX





● MACHINEABILITY—

Tapping All Holes in Faces, Valve-Chamber Cover, and Exhaust Ports, 78 Holes at One Operation. Production 3 per Minute.

Machining the Right and Left Bank Cylinder-Head Faces, with Four Sets of Cutters. Production 35 per Hour.

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MACHINE-CAST, FOUNDRY BASIC AND HEMATITE

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COME AND SEE US AT STAND 16, ROW D,

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RAW MATERIALS—PRICE LIST

(Wednesday, September 25, 1935)

COPPER

	£	s.	d.
Standard cash	34	16	3
Three months	35	2	6
Electrolytic	39	5	0
Tough	37	5	0
Best selected	37	15	0
Sheets	66	0	0
India	49	10	0
Wire bars	39	10	0
Ingot bars	39	10	0
H.C. wire rods	43	0	0
Off. av. cash, August	32	13	6⅜
Do., 3 mths., August	33	1	0⅜
Do., Sttlmnt., August	32	13	5⅞
Do., Electro, August	36	5	0
Do., B.S., August	35	10	10
Do., wire bars, August	36	10	5⅜
Solid drawn tubes			10½d.
Brazed tubes			10¼d.
Wire			6d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11¼d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7⅞d.
Wire	7⅝d.
Rolled metal	7½d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5⅞d.
Do. 4 × 3 Sheets	5⅞d.

TIN

	£	s.	d.
Standard cash	227	0	0
Three months	214	10	0
English	227	5	0
Bars	228	0	0
Straits (nom.)	228	0	0
Australian (nom.)	227	10	0
Eastern	223	0	0
Banca (nom.)	227	10	0
Off. av. cash, August	223	4	8⅜
Do., 3 mths., August	212	19	8⅞
Do., Sttlmt., August	223	4	3⅜

SPELTER

	£	s.	d.
Ordinary	15	18	9
Remelted	15	10	0
Hard	13	10	0
Electro 99.9	18	11	3
English	16	10	0
India	13	15	0
Zinc dust	19	10	0
Zinc ashes	3	5	0
Off. aver., August	14	16	6 3/16
Aver. spot, August	14	14	3⅜

LEAD

	£	s.	d.
Soft foreign ppt.	17	3	9
Empire (nom.)	17	12	6
English	19	0	0
Off. average, August	15	15	7½
Average spot, August	15	15	5½

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	2	6
Do., V.M. ex-whse.	25	5	0
Rods	29	0	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	75	0	0	to	76	0	0
Chinese, ex-whse.					68	0	0
Crude, c.i.f.					33	0	0

QUICKSILVER

Quicksilver	11	0	0	to	11	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£12 15 0
75%	£17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£21 15 0
6/8% car.	£21 0 0
8/10% car.	£21 0 0
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£36 5 0
Max. 0.70% car.	£37 5 0
70%, carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					2	16	0
Mixed iron and steel	2	10	0	to	2	12	0
Heavy cast iron	2	10	0	to	2	13	0
Good machinery	2	12	6	to	2	15	0
Cleveland—							
Heavy steel					2	12	6
Steel turnings					1	17	6
Cast-iron borings					1	7	6
Heavy cast iron					2	12	6
Heavy machinery	2	14	0	to	2	15	0
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					2	17	6
Steel turnings					1	14	0
Scotland—							
Heavy steel					2	10	0
Ordinary cast iron	2	11	6	to	2	12	6
Engineers' turnings					1	19	6
Cast-iron borings	1	17	0	to	1	18	6
Wrot-iron piling					3	0	0
Heavy machinery					2	16	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	18	0	0
Lead (less usual draft)	13	10	0
Tea lead	10	0	0
Zinc	9	10	0
New aluminium cuttings	69	0	0
Braziery copper	23	0	0
Gunmetal	25	0	0
Hollow pewter	150	0	0
Shaped black pewter	116	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	71/-
Hematite M/Nos.	70/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/- to 73/6
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
W.C. hematite	86/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	81/6
Clyde, No. 3	81/6
Monkland, No. 3	81/6
Summerlee, No. 3	81/6
Eglinton, No. 3	81/6
Gartsherrie, No. 3	81/6
Shotts, No. 3	81/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	and up.			
Bolts and nuts, ¾ in. × 4 in.	15	0	0	and up.			
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)					9	7	0
Black sheets, 24g. (4-t. lots)					11	0	0
Galv. cor. shts. (,,)					13	0	0
Galv. flat shts. (,,)					13	10	0
Galv. fencing wire, 8g. plain					14	10	0
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	5	0	to	5	10	0
Tin bars	5	5	0	to	5	10	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	13⅜d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.31
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.85
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	20/- to 21/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 and up.
,,	28×20 ,,	36/4 and up.
,,	20×10 ,,	26/- to 26/3
,,	18⅞×14 ,,	18/9 to 19/-
C.W.	20×14 ,,	15/6
,,	28×20 ,,	32/6
,,	20×10 ,,	22/9
,,	18⅞×14 ,,	15/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Sept. 19 ..	34	8	9	dec.	1/3
„ 20 ..	34	11	3	inc.	2/6
„ 23 ..	34	10	0	dec.	1/3
„ 24 ..	34	8	9	„	1/3
„ 25 ..	34	16	3	inc.	7/6

Electrolytic Copper

	£	s.	d.		
Sept. 19 ..	38	10	0	inc.	5/-
„ 20 ..	38	15	0	„	5/-
„ 23 ..	38	15	0	No change	
„ 24 ..	39	5	0	inc.	10/-
„ 25 ..	39	5	0	No change	

Standard Tin (cash)

	£	s.	d.		
Sept. 19 ..	227	2	6	inc.	5/-
„ 20 ..	226	15	0	dec.	7/6
„ 23 ..	225	15	0	„	20/-
„ 24 ..	224	15	0	„	20/-
„ 25 ..	227	0	0	inc.	45/-

Tin (English ingots)

	£	s.	d.		
Sept. 19 ..	227	5	0	inc.	5/-
„ 20 ..	227	0	0	dec.	5/-
„ 23 ..	226	0	0	„	20/-
„ 24 ..	225	0	0	„	20/-
„ 25 ..	227	5	0	inc.	45/-

Spelter (ordinary)

	£	s.	d.		
Sept. 19 ..	15	11	3	inc.	1/3
„ 20 ..	15	7	6	dec.	3/9
„ 23 ..	15	10	0	inc.	2/6
„ 24 ..	15	10	0	No change	
„ 25 ..	15	18	9	inc.	8/9

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Sept. 19 ..	18	3	9	inc.	1/3
„ 20 ..	18	0	0	dec.	3/9
„ 23 ..	18	2	6	inc.	2/6
„ 24 ..	18	2	6	No change	
„ 25 ..	18	11	3	inc.	8/9

Zinc Sheets (English)

	£	s.	d.		
Sept. 19 ..	24	2	6	inc.	2/6
„ 20 ..	24	2	6	No change	
„ 23 ..	24	2	6	„	„
„ 24 ..	24	2	6	„	„
„ 25 ..	24	2	6	„	„

Lead (English)

	£	s.	d.		
Sept. 19 ..	18	10	0	No change	
„ 20 ..	18	10	0	„	„
„ 23 ..	18	10	0	„	„
„ 24 ..	18	15	0	inc.	5/-
„ 25 ..	19	0	0	„	5/-

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in August and the eight months, 1935, compared with a year ago.

	August.		Eight months.		August.		Eight months.	
	1934.	1935.	1934.	1935.	1934.	1935.	1934.	1935.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	10,785	6,966	68,471	50,162	31,351	20,664	190,972	149,872
„ Foreign Countries	555	1,491	9,761	9,499	3,553	9,117	55,370	55,902
Total	11,340	8,457	78,232	59,661	34,904	29,781	246,342	205,774
Castings and forgings	336	391	2,724	2,064	9,000	9,812	69,019	53,063
Cast pipes and fittings	51	123	764	1,079	2,832	3,724	42,100	26,400
Stoves, grates, etc.	265	66	770	849	14,150	6,589	62,804	70,475
Baths	806	635	5,220	4,729	20,872	15,188	129,202	125,597
Hollow-ware, all kinds	185	211	1,619	1,689	12,375	13,443	92,875	112,799
Exports.								
Pig-iron, forge	75	97	729	1,026	299	518	3,024	4,681
„ foundry	7,370	7,294	48,462	61,892	23,691	26,058	163,700	214,613
„ acid	4,206	3,916	29,970	33,444	13,282	12,262	94,819	108,348
„ basic	24	—	832	231	89	—	2,725	727
Total	11,675	11,307	79,993	96,593	37,361	38,838	264,268	328,369
Castings and forgings	618	400	3,461	2,911	24,800	12,123	131,918	107,568
Cast pipes and fittings, up to 6 in. diameter	4,255	5,549	41,076	38,253	48,378	61,905	452,389	422,785
„ „ „ over 6 in.	3,089	1,723	25,333	23,487	19,774	14,436	186,358	183,645
Stoves, grates, etc.	889	794	5,714	5,618	33,931	39,921	256,764	281,863
Sanitary cisterns	224	214	1,965	2,035	6,571	6,591	57,770	59,501
Bedsteads, inc. tubes therefor	521	358	3,515	2,800	16,357	13,897	115,217	103,947
Cast hollow-ware	275	288	2,291	2,542	10,996	10,510	87,686	96,956

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

APPOINTMENT wanted in Manchester as Resident Engineer for blast furnaces producing foundry pig-iron and other foundry material.—Address Box 392, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN BRASSMOULDER SEEKS SITUATION IN SAME CAPACITY. Experience in aluminium and all non-ferrous work. Strict disciplinarian. 16 years in control.—Box 406, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN or Assistant position required; age 44; 30 years' experience gas and electric stoves, rain-water and motor castings; iron and aluminium latest methods.—Keen, 85, Southbury Road, Enfield, Middlesex.

FOUNDRY MANAGER with one of the largest foundries in England desires change. At present producing 650 tons per month on castings varying from lbs. to 70 tons. Thoroughly conversant with all metals and mixing to analysis. Strict disciplinarian and good control of a large number of men. Maximum production from cupolas at a minimum cost. Four years in present position. Advertiser is not a cheap man. For further particulars, Box 410, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MANAGER seeks more progressive appointment. General engineering; capable buyer; designer; extensive repetition foundry work; estimating, planning, mass-production light machinery, lawn mowers, and sales experience. Excellent personality. Salary £650.—Box 388, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN required in general grey-iron foundry in Midlands, producing castings up to 3 tons. State age, experience and wages required.—Box 404, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN for foundry in Midlands producing small high-class grey-iron repetition castings and general work up to 10 cwts.; also non-ferrous castings. Must be experienced in mixing metals. State wages required and previous experience.—Box 402, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY MANAGER requires similar position or as equipment representative. Special knowledge high-duty irons and cupola practice. Extensive experience repetition work, including machine moulding, also general engineering. (267)

ASSISTANT FOREMAN MOULDER requires change. Good experience in iron and steel, general engineering and also specialised work. (268)

SITUATIONS VACANT AND WANTED.—*Contd*

MAN REQUIRED for rate-fixing and time-study work by large foundry situated in Midlands. Must have had first-class experience on large dry-sand work. Write giving full particulars and salary required to Box 412, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. A new edition will be going to press soon. *Write now* for full particulars and advertisement rates.—Industrial Newspapers, Limited, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

MORGAN Tilting Furnaces, various sizes in stock.—Alex. Hammond, 14, Australia Road, Slough.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. Davies & Son, West Gorton, Manchester.

AIR COMPRESSORS, all sizes, in stock.—Alex. Hammond, 14, Australia Road, Slough.

PATENT Sand-Mixing Machine (Whizzer), double-cage type; ball bearings throughout; cost £120 when new; price £40 or near offers.—Newbys, Phœnix Foundry, West Bromwich.

BORRMAN Core-blowing Machine, as new, scarcely used, cheap.—Alex. Hammond, 14, Australia Road, Slough.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

THOS. W. WARD LTD.

Unused "Rateau" BLOWER (Fraser Chalmers); 18" sq. outlet; 12,000 cub. ft. air p.m. at 2½ lbs. press.; arranged for motor drive.

Jar-ram turnover MOULDING MACHINE for boxes 21" x 16".

8-ton geared FOUNDRY LADLE, 4' 3" high, 4' dia.

Two first-class Babcock W.T. BOILERS; new in 1927; heating surface 1,966 sq. ft. each; 205 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS

FLOORPLATES, cast iron and steel, various sizes, in good condition.—Holinter, Ltd., Leeds Steel Works, Leeds.

METALLOGRAPHY.

"DAVON METALWORKS" semi-automatic visual and photographic outfit. Demonstration model (slightly soiled) at 20 per cent. reduction.—F. Davidson & Co., 143, Great Portland Street, London, W.1.

FOR SALE cheap, good assortment of Moulding Boxes, Snap Flasks, a Lathe, and various Blowers.—Box 408, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—Furmston & Lawlor, Letchworth.

TWO TONS of steel-strip scrap available monthly, containing 20-22 per cent. chromium. What offers?—Box 400, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

SAND PLANT

Herbert Whizzer, large size. **£48.**
Brealey Disintegrator, NEW. **£26.**
Pneumatic Riddles, Jackman type. **£9 each.**

SANDBLAST PLANT

BARREL PLANT by Tilghman, *as new*, 60" × 40". Price **£240.**

NEW 8' × 8' ROOM PLANT, complete. Price **£230.**

CAST IRON ROOM PLANT, 12' × 9', complete with 400 cu. ft. motor-driven compressor for A.C. current, in new condition. Cheap.

Several small complete barrel plants in stock.

Genuine Stevenson 30-ton Crane Ladle, NEW. Price **£75.**

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun and on occasions—be it admitted—of naughtiness.

Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception.

Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d a year to you. Send Peter and his handicapped pals 3d for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,
SCHOOL FOR THE BLIND
(Founded 1838)
SWISS COTTAGE, LONDON, N.W.3